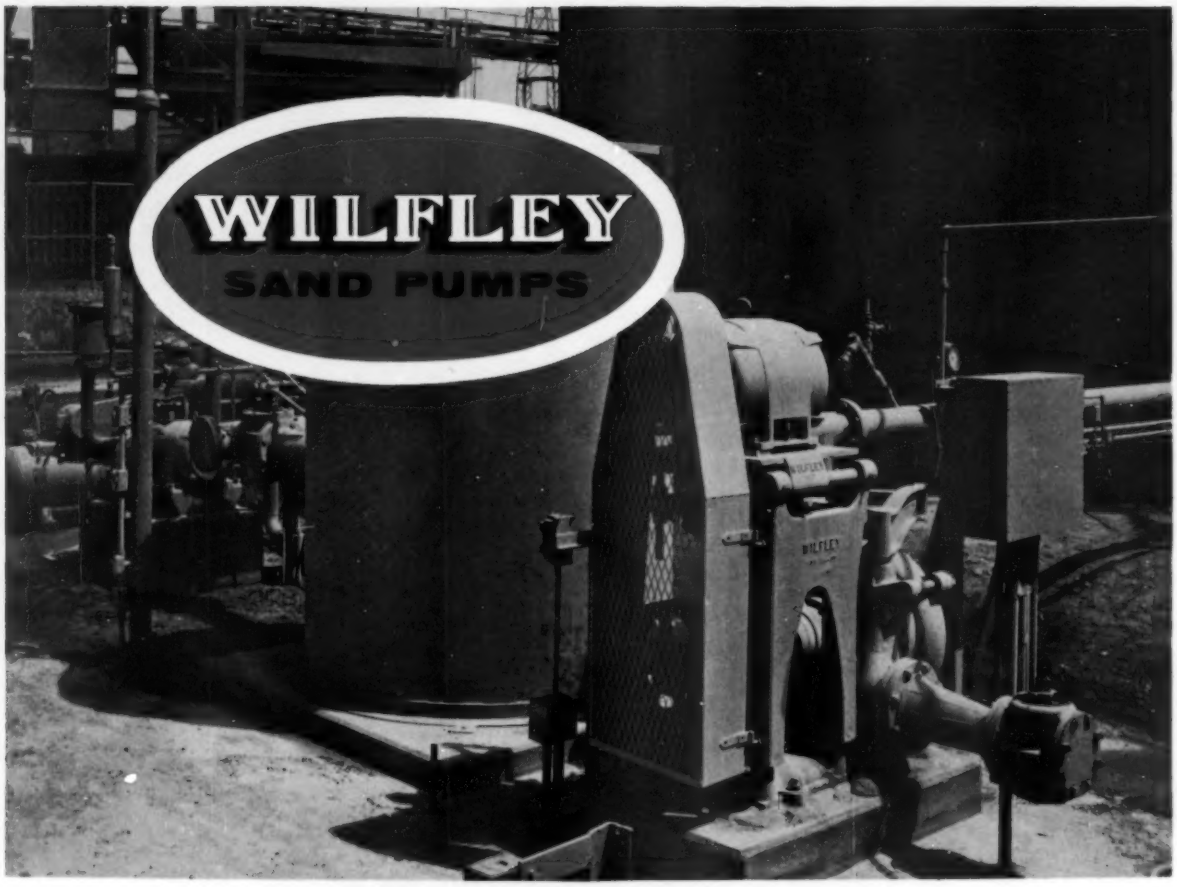
MINING engineering

FEBRUARY 1961

ANNUAL REVIEW

FUTURE TOOLS FOR MINE MANAGEMENT



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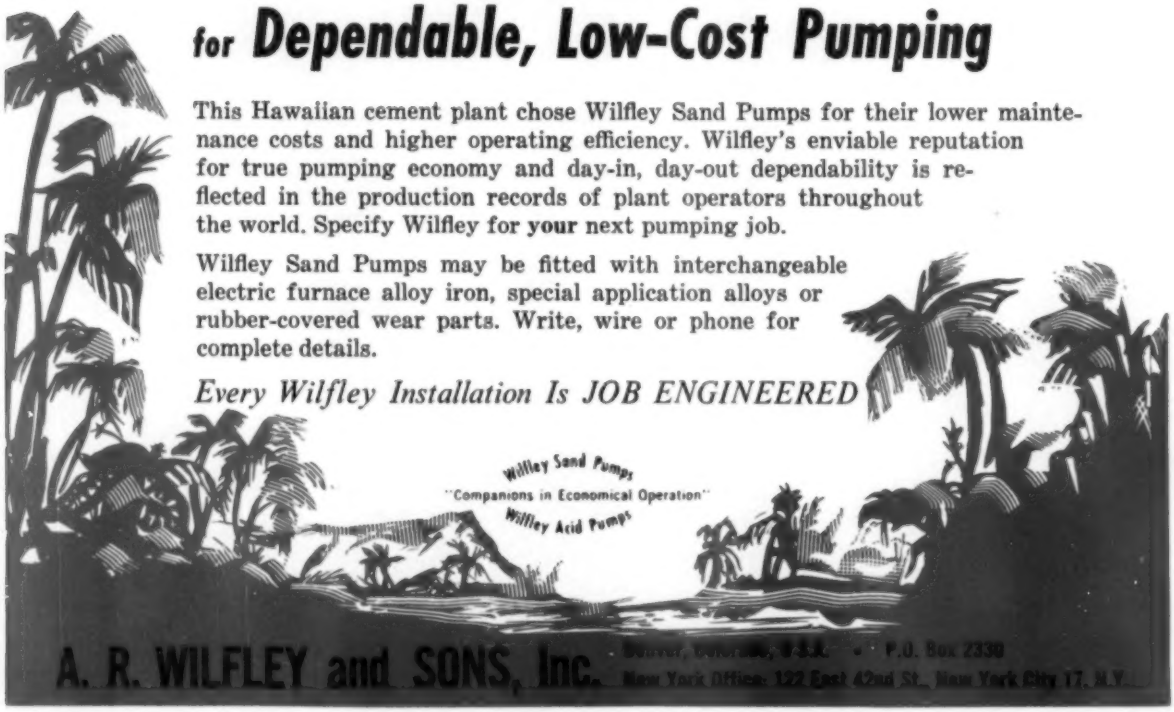

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New York Office: 122 East 42nd St., New York City 17, N.Y.

COMING EVENTS

Mar. 30-Apr. 1, Fourth Symposium on Rock Mechanics, sponsored by mining departments of Colorado School of Mines, University of Minnesota, Missouri School of Mines and Metallurgy, and The Pennsylvania State University. The Pennsylvania State University, University Park Pa.

Apr. 4-7, Short Course on computers and application for managerial and technical personnel in minerals industries. University of Arizona, Tucson. Address E. R. Drevdahl, College of Mines, University of Arizona.

Apr. 7-9, Sixth Annual Mining, Minerals, and Petroleum Conference, AIME Southwestern Alaska Section, Anchorage, Alaska, **has been cancelled.**

Apr. 9-11, Society of Exploration Geophysicists 14th Annual Midwestern Meeting, Skirvin Hotel, Oklahoma City, Okla.

Apr. 10-11, ASME Maintenance and Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

Apr. 10-12, 44th National Open Hearth Steel Conference and Blast Furnace, Coke Oven, and Raw Materials Conference, Sheraton Hotel, Philadelphia.

Apr. 12-14, International Symposium on Agglomeration, sponsored by SME, SPE, and TMS of AIME, Sheraton Hotel, Philadelphia.

Apr. 17-19, CIM Annual Meeting, Chateau Frontenac, Quebec.

Apr. 20-22, 76th Annual Convention, Illinois Society of Professional Engineers, Peoria, Ill.

Apr. 23-26, ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

Apr. 24-25, AIME Southwest Minerals Industry Conference, sponsored by SME Industrial Minerals Division and AIME Nevada Section. Stardust Hotel, Las Vegas, Nev.

Apr. 26-27, AIME Technical Conference on High-Temperature Materials, Carter Hotel, Cleveland.

May 7-11, ASME—Engineering Institute of Canada Hydraulic Conference, Queen Elizabeth Hotel, Montreal.

May 12-14, Sixth Annual Uranium Symposium, sponsored by AIME Central New Mexico Section. Grants, N. M.

May 15-18, Coal Show of the American Mining Congress, Cleveland. Suggestions for topics to be included in program should be sent to American Mining Congress, Ring Bldg., Washington 6, D. C.

May 25-26, 37th Annual Conference, Lake Superior Mines Safety Council, Hotel Duluth, Minn.

June 6-8, Sixth Annual Appalachian Underground Corrosion Short Course, West Virginia University School of Mines, Morgantown, W. Va. For information write John H. Alm, Publicity Chairman, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.

June 6-8, National Coal Assn., 44th Annual Meeting, Mayflower Hotel and Coal Bldg., Washington, D. C.

Jun. 28-30, ASME—University of Colorado Joint Automatic Control Conference, University of Colorado, Boulder, Colo.

Aug. 28-Sept. 1, ASME—University of Colorado International Heat Transfer Conference, University of Colorado, Boulder, Colo.

Sept. 11-13, American Mining Congress Metal Mining—Industrial Minerals Convention, Seattle, Wash.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Minerals Beneficiation Division, Brown Palace and Cosmopolitan Hotels, Denver.

Oct. 2-3, Joint Meeting, SME Industrial Minerals Division of AIME—CIM, Ottawa.

Oct. 5-7, Joint Solid Fuels Conference, Birmingham, Ala.

MINING engineering

VOL. 13 NO. 2 FEBRUARY 1961

COVER *With the bite of the shovel, the process of changing ore to finished product begins its endless sequence. Artist Herb McClure has used the shovel as a symbol of today's mining methods, much as the hand shovel was a symbol of yesterday's methods. But new tools and better tools reviewed in the following pages promise even more effective mining methods tomorrow.*

ANNUAL REVIEW

SPECIAL REPORT ON . . .

ARTICLES

DEPARTMENTS

FEATURED ITEMS

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

Address insertion orders and copy to MINING ENGINEERING, 29 W. 39th St., New York 18, N. Y. Send plates to: MINING ENGINEERING, c/o Lew A. Cummings Co. Inc., 215 Canal St., Manchester, N. H. Published monthly by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 W. 39th St., New York 18, N. Y. Telephone: PEnnsylvania 6-9220; TWX NY 1-1304. Subscription $8 per year for non-AIME members in the U. S., & North, South, & Central America; $10 all other countries; $6 for AIME members, or $4 additional for members only in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies, $.75; single copies foreign, $1.00; special issues, $1.50. AIME is not responsible for any statement made or opinion expressed in its publications.

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include 8¢ in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18,** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Operations Superintendent, mining engineer, age 37. Seven years experience, of which four and a half have been in highly mechanized open pit metal mining. Knowledge all phases from pre-mining drilling to shiploading. Any location. M-584.

Manager for mine or quarry, B.S. in mining engineering, age 51. Twenty-eight years all phases of open pit mining using truck, corregor or railroad haulage, heavy equipment, and big tonnages. Available immediately. Prefer U.S. M-2057-Chicago.

Field or Mining Engineer, B.S. in mining engineering, age 29. Twenty months photogrammetry field control, computations, party chief, planning; seven months field engineer bridge construction; three summers underground western metal mines. Prefer U.S., will consider foreign. M-2058-Chicago.

POSITIONS OPEN

Technical Products Sales Engineer to sell flocculants, mining and settling reagents. Some background as mill superintendent or

(Continued on page 105)

WANTED—*Manager experienced in flotation operations* to head flotation mill for concentration of beryl, etc., in Brazil. Write:
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WANTED

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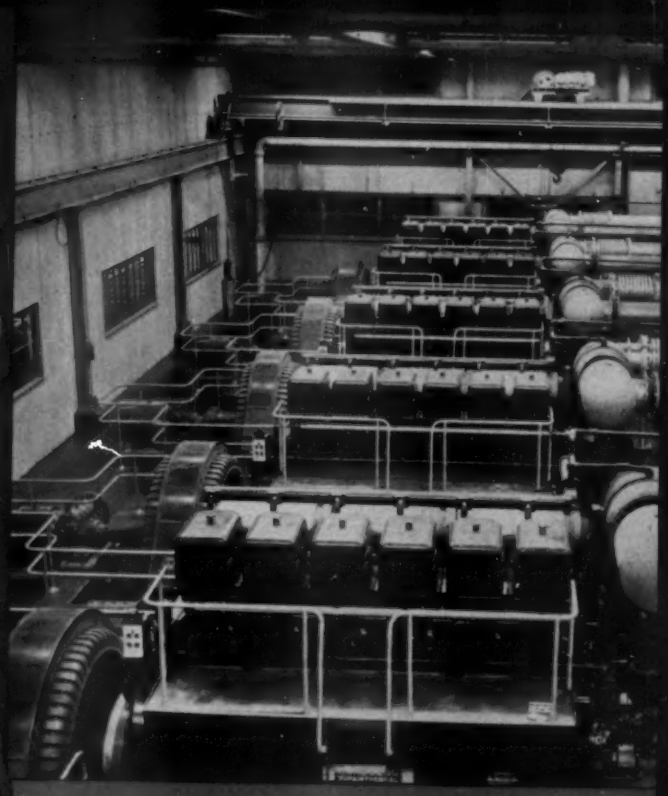
HOW NORDBERG MACHINERY SERVES THE MINING INDUSTRY



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Nordberg engines are built in sizes ranging from small power units to over 12,000 horsepower in a single engine . . . and are available for Diesel, Dualfuel® and Spark-Ignition Gas operation.

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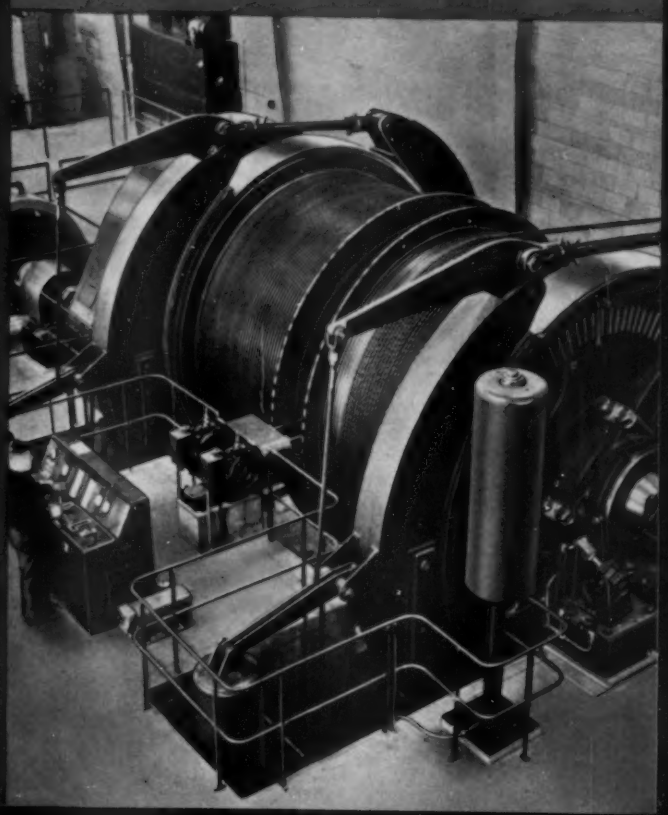
Nordberg has an established reputation second to none, and can furnish both conventional and friction type mine hoists for men and material, to meet specific requirements.



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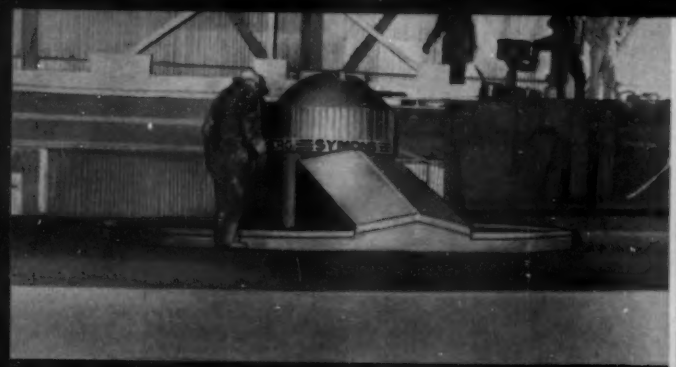
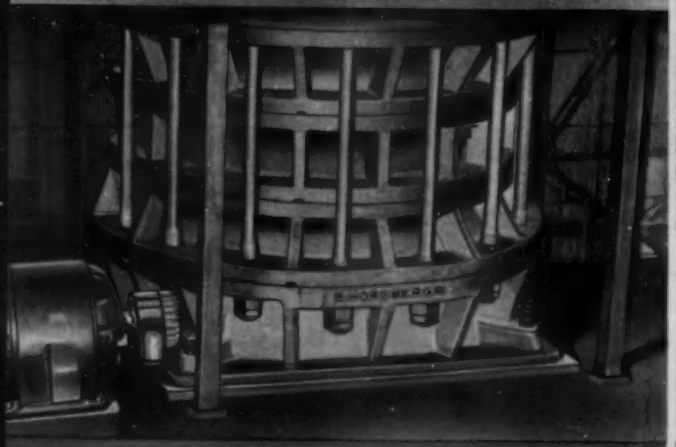


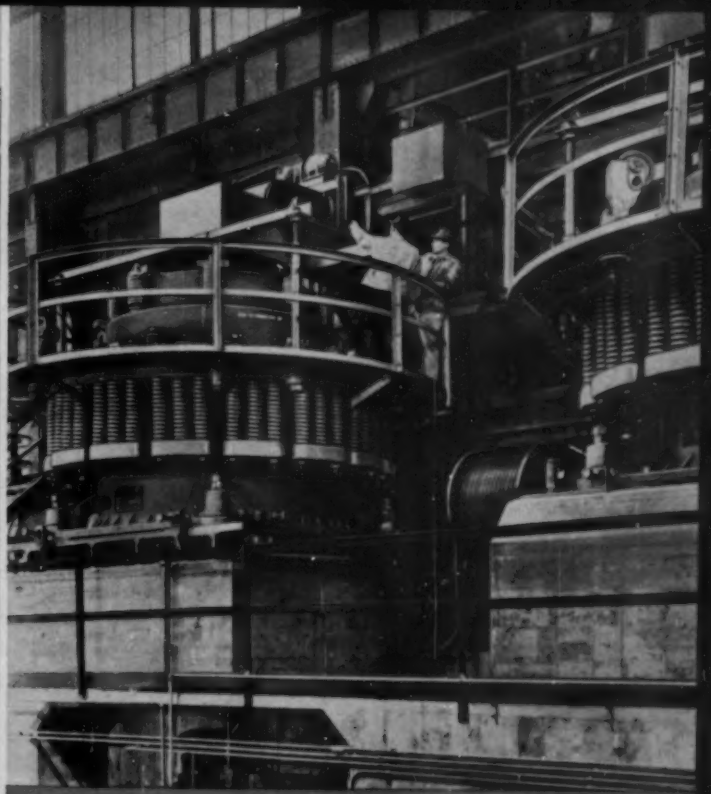


IN PRIMARY CRUSHING

Symons® Primary Gyratory Crushers are built for big tonnage, heavy duty primary breaking in 30", 42", 48", 54", 60" and 72" feed opening sizes. Capacities to 3500 or more tons per hour.

IN SCREENING

From scalping to fine screening, there is a Symons Screen built to do a better job at low cost. Let Nordberg experience help you select the screen best suited to your needs.



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Symons Cone Crushers, the machines that revolutionized crushing practice, are built in both Standard and Short Head types, in sizes from 22" to 7' in diameter. Capacities from 6 to 900 or more tons per hour.

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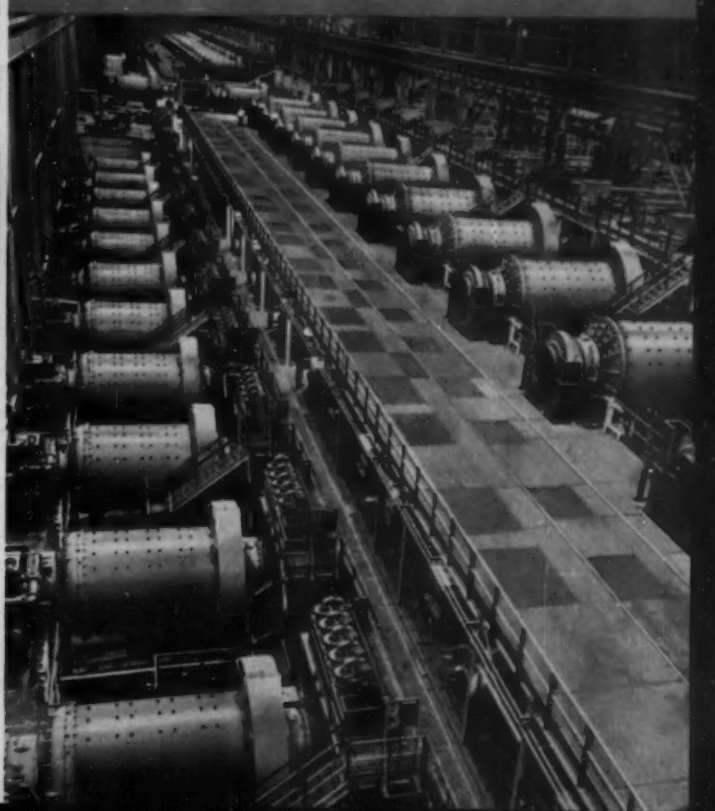
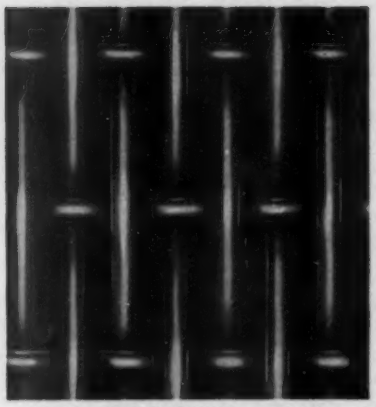
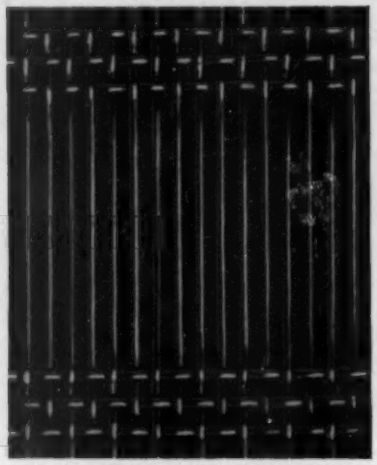




MAXIMUM THROUGHPUT — CF&I Space Screens with Rectangular Openings have high percentage of open area, provide considerable freedom from blinding and clogging.

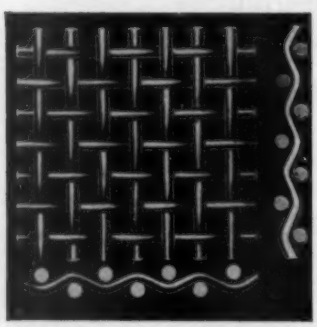


FREEDOM FROM CLOGGING AND BLINDING — The greater open area of CF&I Long Slot Space Screens, plus intense vibration of wires on the long sides of openings, prevents material build up.

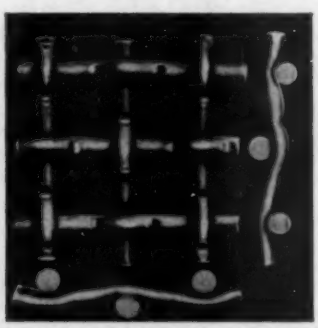
You get selectivity with CF&I Space Screens

Whether you want high throughput, maximum accuracy or long service life, there's a CF&I Space Screen that will give you the results you're looking for. You can choose from screens with almost any combination of openings, weaves and crimps, edge preparations and effective open areas. CF&I has the experience and facilities — as symbolized by our Corporate Image — to supply screens to meet your most exacting requirements.

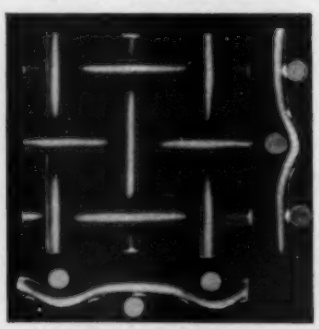
All CF&I Screens are available in a complete range of metals including carbon, alloy and stainless steels, aluminum, bronze, Monel and many other alloys. For further information on the screens described here or on any in the CF&I line, contact a local CF&I sales office.



LONG LIFE — Even under severest operating conditions Double Crimp cloth is most effective. That's because it's built so all wires get equal wear.



VERY ACCURATE SIZING — Because each wire of Lock Mesh Cloth is constructed in a "locked-in" position, it's one of the best available for vibrators and trommels.



MINIMUM RESISTANCE TO MATERIAL FLOW — With all the crimping on the underside, CF&I Space Screens with Flat Weave set up minimum turbulance to materials going through.

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Cost Engineering in the Process Industries, edited by Cecil H. Chilton and others, *McGraw-Hill Book Co. Inc.*, 475 pp., $11, 1960—This is a compilation of articles which are still relevant from the series published by *Chemical Engineering* magazine from 1947 through December 1959 dealing with cost estimation and engineering economics in the process industries. Where cost data is expressed in dollars, an appropriate date or index level is included so that the data may be corrected for current use by comparison with the cost indexes included in the volume. • • •

Asphalts and Allied Substances, Vol. I: Historical Review and Natural Raw Materials by Herbert Abraham, Sixth Edition, *D. Van Nostrand Co. Inc.*, 370 pp., $10.75, 1960—This newest edition of a standard reference guide covers as before the fabrication, merchandizing, and application of bituminous products, but is published now in five volumes. Vol. I presents a brief historical review, terminology, classification, and the chemistry of bituminous substances, and discussion of natural raw materials, including geographical locations of known world asphalt deposits, and methods of mining, transporting, refining, and storage. Subsequent volumes will treat industrial raw materials, manufactured products, and methods of testing. • • •

Perchlorates: Their Properties, Manufacture and Uses, edited by Joseph C. Schumacher, *Reinhold Publishing Corp.*, 257 pp., $8.75, 1960—Members of the research staff of American Potash & Chemical Corp. contribute the twelve sections of this monograph, a comprehensive survey of its subject. It covers metal, ammonium, alkaline earth, and miscellaneous organic and inorganic perchlorates; perchloric acid; uses, e.g., in explosives and propellants, as a catalyst, and in photography; biological action and safety considerations in handling; and aqueous systems. There are extensive references and tables of statistical data on perchlorate production. • • •

First Revision, Standard of the Hydraulic Institute—10th Edition, *The Hydraulic Institute*, 122 E. 42nd St., New York 17, N. Y., 75 pp., $1.25, 1960—The 10th edition of this work has been revised and the revised pages are available to present owners of the book. These revised pages are printed on colored stock, and their insertion in the original looseleaf cover will bring the entire book completely up to date. Some of the important changes are clarifications and corrections involving drawings, nomenclature, and text; new definitions; revisions in the test code for centrifugal pumps; and calculation of volumetric efficiency of reciprocating pumps, using compressibility factors for water and for hydrocarbons. For those who are interested in obtaining the complete Standards (including the revised pages) the price is $6 in the U.S. and $6.50 foreign. • • •

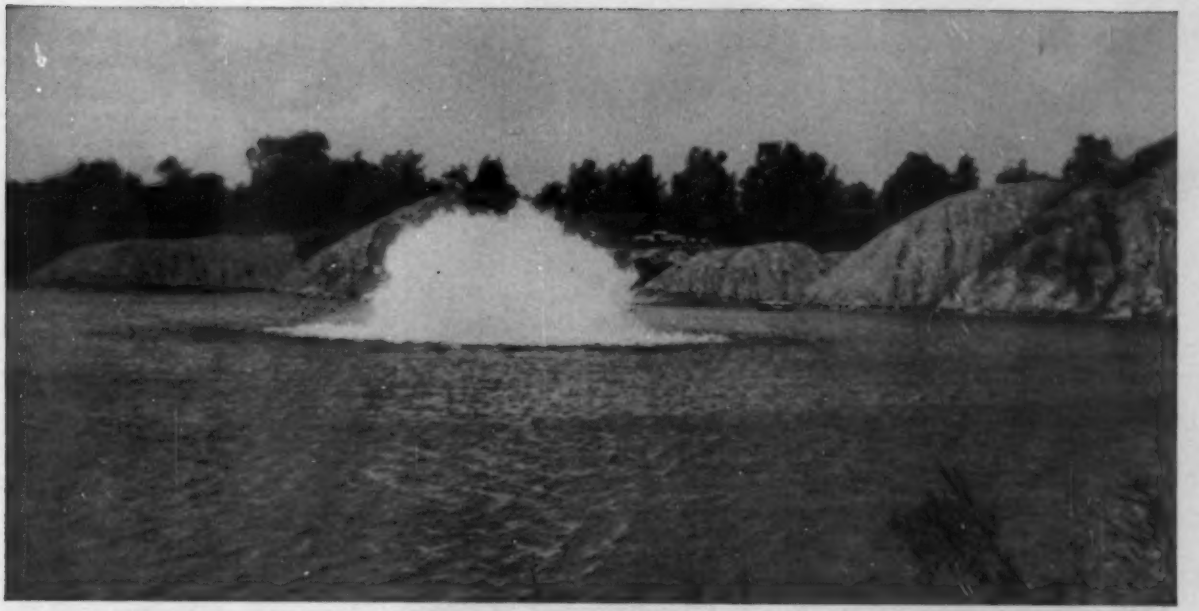
A Guide to the Known Minerals of Turkey, revised by C. W. Ryan, *International Cooperation Administration*, 196 pp., gratis. 1960—This compilation of mineral occurrences in Turkey, originally revised in 1957 by C. W. Ryan, has recently been reprinted. The book contains brief descriptions of approximately 3300 mineral localities, and it is accompanied by a 1:2,500,000 scale map of all major mineralized areas within that country. Copies may be obtained by writing to the U.S. Operations Mission to Turkey, Ankara, Turkey.

Minerals Beneficiation Issue, *Journal of Mines, Metals & Fuels*, 6/2, Madan St., Calcutta 13, India, 178 pp, approx. $2.52 (12/Rs), 1960—A symposium on beneficiation of minerals was held at the Indian Institute of Science, Bangalore, on Sept. 29 and 30, 1959, as a part of the Institute's Golden Jubilee celebrations. This special issue of the magazine carries the entire proceedings of the symposium, a preface, the welcoming address by M. R. A. Rao, and the presidential address by B. Rama Rao. Thirty papers were presented covering broadly the theory of grinding, flotation theory and practice, heavy media and hydrocyclone methods in the beneficiation of pyrites and coals, phase separation methods for demineralization of coals and graphites, and chemical methods including the theory and practice of chlorination. Among the papers presented was one on the theory of tumbling mills by U. N. Bhrany and N. Arbiter. Others included were *Kinetics of Decomposition of Xanthates in the Presence of Ferric Salt* by S. Ramachandra Rao and C. C. Patel; *Recovery of Economic Minerals from Kerala Sands* by J. Y. Somnay; and *Thermodynamics of Chlorination of Titanium Minerals* by G. V. Jore and C. C. Patel.

International Mineral Processing Congress 1960, *The Institution of Mining and Metallurgy*, 44 Portland Place, London, W. 1, England, 1109 pp., $14.50, 1960—This volume covers the Proceedings of the International Mineral Processing Congress held April 6-9, 1960, in London. An idea of the scope of the material covered during the meeting was indicated in an article by H. Rush Spedden on page 677 of the July issue of MINING ENGINEERING. Fifty-two original papers covering theory and practice were discussed during nine technical sessions under the headings: Comminution, Classification and Thickening, Flotation Research, Flotation Practice, Gravity and Dense Media Separation, Magnetic and Electrical Separation and Sorting, Chemical Processing, Process Study, and Control and Testing. The Proceedings volume includes the papers presented, together with the numerous and important contributions to the discussion, and the authors' replies to questions and criticisms. In all, the volume contains contributions from 168 specialists in this field from 24 countries.

Energy in the American Economy 1858-1975 by Sam H. Schurr and Bruce C. Netschert *et al.*, *The Johns Hopkins Press*, Homewood, Baltimore 18, Md., 774 pp., $12.50, 1960—This comprehensive study of energy's role in the U.S. economy provides a background for answers to such questions as: What are the likely patterns of energy supply and demand in 1975? What was the relationship between energy use and economic growth in the U.S. and what implications does it carry for

(Continued on page 104)



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Spencer N-IV And Fuel Oil Produces Up To 7 Times As Much Useful Energy Per Dollar

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BOOKS

(Continued from page 102)

the future? What is the meaning of the nation's recent change from a net exporter to a net importer of mineral fuels? Part I is an analysis of the era when fuel dominance shifted from wood to coal and from coal to oil and gas—an era which saw the rise of electrification; Part II assesses the future demands for energy; and Part III analyzes the supply of our future energy. • • •

Capital in Manufacturing and Mining by Daniel Creamer, Sergei P. Dobrovolsky, and Israel Borenstein, *Princeton University Press*, Princeton, N. J., 344 pp., $7.50, 1960—The latest of a series of similar comprehensive studies conducted by the National Bureau of Economic Research. Part I analyzes capital and output trends in manufacturing and mining industries, including measurement of industry growth, history of growth from 1870 to 1953, trends in capital-output ratios, and trends in ratios of fixed and working capital to output. Part II surveys the long-term trends in capital financing, and Part III contains notes on estimates of capital, output, and employment in both manufacturing and mining for the period 1870 to 1953. • • •

Canada

Government Publications

Queen's Printer
Ottawa, Ontario

Review and Evaluation of Methods of Particle Size Analysis, Information Circular IC 106, 25¢, 1959.
Physical Metallurgy and Uses of Gold Bibliography for the Ten-Year Period 1950 to 1959, Information Circular IC 116, 25¢, 1960.
Directory and Bibliography of High Temperature Condensed States Research in Canada and Elsewhere, 1959, Information Circular IC 117, 25¢, 1960.
Industrial Water Resources of Canada, Water Survey Report No. 10, Cat. No. M32-861, $1, 1959.
Markets for Iron and Steel Products in Western Canada, Mineral Information Bulletin MR33, 25¢, 1959.
Survey of the Copper Industry in Canada 1958, Mineral Information Bulletin MR37, 50¢, 1959.
Some Economic Factors Affecting Northern Mineral Development in Canada, Mineral Information Bulletin, MR38, 50¢, 1959.
A Survey of the Natural Gas Industry in Canada 1957-1959, Mineral Information Bulletin MR39, 50¢, 1960.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is*

given the proper permanent reference to the paper for bibliography purposes.

Annual Review covering exploration, mining, and beneficiation. **Ref.** (MINING ENGINEERING, **February 1961) pp. 146-181.**

Contract Pay System at Butte by *V. D. O'Leary* —The agreements between The Anaconda Co. and its miners are not contracts in the true sense of the word. They are tacit agreements in which the company supplies the opportunity and equipment while the miners furnish the labor for the ultimate purpose of benefiting both parties.

Prices are not discussed at hiring but can be after the contract has started operating. Prices are set from schedules founded on the years of experience of operating staffs and engineers on what constitutes a fair day's work. The schedules are flexible enough to meet changing physical conditions. They are adjusted when newer mining methods or newer equipment makes it imperative.

Miners can be critical of measurements, can demand re-measurements, and if they wish, can process any complaint through the normal grievance procedure. They can discuss conditions and equipment, as well as prices, with the mine superintendent.

The mine superintendent is in full control of prices and has considerable latitude in handling his contracts. However, he is limited by contract costs, and he must be prepared to justify unusual actions.—The Butte contract system has proved to be popular with miners and has been very successful in its operation. It can remain so only as long as the company retains full control. **Ref.** (MINING ENGINEERING, **February 1961) p. 186.**

Fighting Fire With Foam at Montour No. 4 Mine by *C. William Parisi*— The use of foam plug in controlling mine fires had its first real test recently in a large modern coal mine in western Pennsylvania. Combatting coal mine fires in the Pittsburgh Seam is difficult because of the overlying laminations of coal and shale which fall as a result of the heat generated by the fire. This fire was no exception. The fire was fought directly with water, delivered at approximately 200 gpm for 9 hr, until it became apparent that no progress was being made. The fire fighters were forced back repeatedly because of the smoke and roof conditions. Preparations were made to install a foam generator, which was placed in operation after a total elasped time of 8 hr from the discovery of the fire. Intermittent operation of the foam generator enabled the fire fighters to again attack the fire directly with water until a decision was made to seal off the area. Continued use of the foam generator during sealing operations permitted some seals to be constructed within 200 ft of the fire while providing greater safety for the workman engaged in the sealing operation.

The foam plug proved itself to be capable of controlling coal mine fires and worthy of consideration as a valuable addition to conventional fire fighting equipment. **Ref.** (MINING ENGINEERING, **February 1961) p. 190.**

PERSONNEL

(Continued from page 94)

mill engineer in ore beneficiation. $10,000 to $12,000. New York City. W9931.

Geologist with either geological engineering with major or experience in mining, or mining engineering degree with major or experience in geology. Approximately five years experience. Job will cover geological and mining work extending from geological reconnaissance through to complete development of mineral properties. Upstate New York. W9773.

Geophysicist or Geologist with gravity and magnetometer survey experience for ground water project. Salary open. Mideast. F9770.

Chief Engineer for process design, plant design, new plant construction and supervision of office for large operation of mining company engaged in phosphate rock mining and processing. Operations cover strip mining, hydraulic transportation, washing and screening plants, flotation plants, drying mill, grinding plant, and calcine plant. South. W9721.

Mill Superintendent who has had experience with large-scale operation. Pennsylvania. W9896.

Assistant Mine Manager for fluorspar mine, graduate mining engineer, about 40, familiar with mining and milling, flotation, medium-size mill. Must know shaft sinking, stoping, etc. Salary open. Newfoundland. F9375.

RIPPING WITH D9 ELIMINATES SHOOTING SANDSTONE AT THIS MODERN STRIP MINE

Expensive, time-consuming blasting of overburden is a thing of the past at the Harrisonville, Ohio, strip mine of the Swisher Coal Company. Caterpillar D9 Tractors with No. 9 Rippers loosen the sandstone overburden, which is then removed by a fleet of Cat DW21 Tractors, pushloaded by D9s.

In addition to saving the cost of shooting, the Pomeroy, Ohio, company saves the cost of reclamation. DW21s spread the excavated overburden over a large area, eliminate spoil banks entirely. The overburden averages 50 feet, covers a 2-foot coal seam. Production at the mine averages from 1000 to 1200 tons daily.

D9 Tractors with No. 9 Rippers pay big dividends on modern stripping operations. (1) They save time and expense of blasting; (2) reduce wear and tear on loading equipment; (3) eliminate troublesome chunks; and (4) they are versatile—can build roads, clean up and handle other utility jobs.

And now the "King of the Crawlers" is even more rugged, more powerful! The new D9E has a massive new undercarriage that adds hours of life to running gear. A new Caterpillar-developed steel alloy strengthens links, shoes, rollers up to 40%. And the mighty new D9 packs 335 HP in its Turbocharged Engine.

Get the whole story from your Caterpillar Dealer. The new D9E is now available with revolutionary new torque divider power shift transmission. Ask for a demonstration on your stripping operation; you'll see more profit in every pass.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

NEW D9E—
BORN OF RESEARCH
PROVED IN THE FIELD

MANUFACTURERS NEWS

NEWS / EQUIPMENT / CATALOGS

95-Ton Capacity Production Truck

KW-Dart Truck Co. has introduced a 95-ton payload tractor-trailer combination to the mining industry. Powered by a 700-hp V-12 diesel engine, the vehicle has a unique

steel frame design, ten tires with demountable rims, a special high efficiency radiator with a frontal area of 3100 sq. in., and an offset one-man cab that permits excellent visibility in all directions. **Circle No. 1.**

Permissible Hand-Lamp

A lightweight hand-lamp, approved by the USBM for use in gas-laden atmospheres, combines a rechargeable 20 amp-hr battery with the most powerful bulb reportedly ever sanctioned for this type of light. The battery is essentially spillproof, has corrosion-resistant terminals, and automatic filling control. Made by *Carpenter Mfg. Co.*, this lamp (Type PBF-5R) and its dry battery equivalent (Type PBF-5) are designed to give an area coverage up to five times that of other types. Lamp shell and handle are of single-piece aluminum construction, and the battery case and cover are of cast aluminum. **Circle No. 2.**

Portable Crushers

Two portable primary crushing plants, designated models 4336 and 3026 Single Impeller Impact Breakers, have been introduced by *Iowa Mfg. Co.* Requiring only a minimum of disassembly to meet road weight limits, the crushers are reported to be ideally suited for use in material with low silica content and able to produce a high volume of cubical aggregate with low percentage of fines, slabs and slivers. Model 4336 has a 200 to 400-tph capacity and Model 3026 has a 150 to 250-tph capacity, capacity depending on material and product size. The units are equipped with a vibrating grizzly-type pan feeder which bypasses fines and undersize material, impact bars to absorb loading shock, and easily replaceable liners to reduce wear to the feeder body. **Circle No. 3.**

Air Sampler

A portable air sampler from the *Staplex Co.* can accurately sample large volumes of air by means of a filter pickup capable of capturing particles as small as 1/100th of a micron. Originally developed by the AEC, the unit is designed for detecting and measuring radioactive par-

ticles in mines and plants as well as detecting beryllium dust. The device weighs 10 lbs, is mounted on a tripod, and is equipped with a 49-hp pump and a high-speed motor (15,600 rpm). **Circle No. 4.**

Fire Resistant Hydraulic Fluid

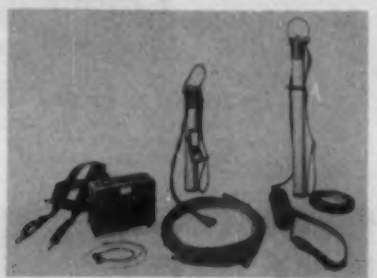
Gulf FR Fluid, marketed by the *Gulf Oil Corp.*, combines fire resistant qualities with lubrication equivalent to all-oil fluids. Competitive in cost with straight mineral oil, FR Fluid is an emulsification of 40 pct water in oil. Each droplet of water is coated with oil and, in the event of fire, the droplets turn to steam and aid in snuffing out the flames. The fluid is reported to be practical for use under all pressures and temperatures normally encountered in underground mining equipment. It is also available in concentrate form for on-site preparation. **Circle No. 5.**

Air Compressor

Availability of a 100-hp air compressor delivering 509 to 565 cfm at pressures to 125 psi has been announced by *Atlas Copco.* Designated the DT4, the 2200-lb unit is a two-stage, double-acting, fully air-cooled compressor designed for stationary or semi-portable installations. A special model for mines has compressor and motor mounted on a skid frame. The unit is built for direct drive by standard electric motor or diesel engine via flexible coupling. Reportedly requiring 30 to 50 pct less space than other similar-capacity compressors, the unit's roughing-in dimensions are 57 in. wide, 49 in. deep, and 46 in. tall. **Circle No. 6.**

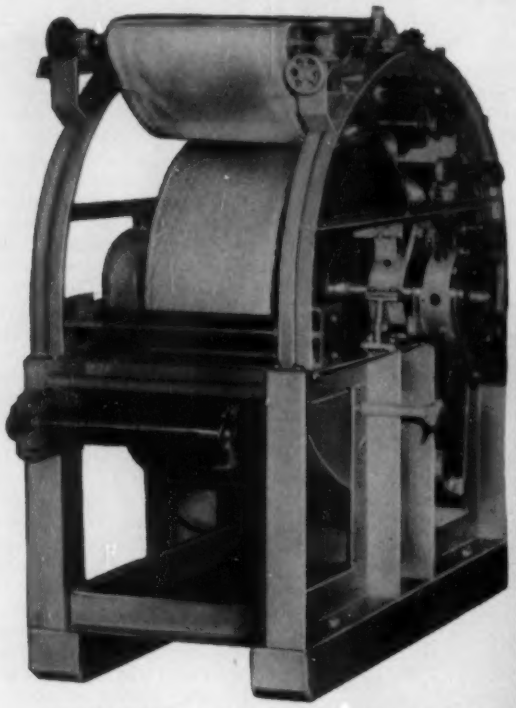
Electromagnetic Prospecting Tools

The newest models in *ABEM's* series of portable, self-contained ground equipment for reconnaissance and detailed surveys by electromagnetic inductive method are listed as E.M.



Gun 17/44 and E.M. Gun 35/88. Reportedly permitting discrimination between different types of conductors, the units are useful for rapidly pin-pointing anomalies discovered through airborne surveys. Choice of frequencies is available. **Circle No. 7.**

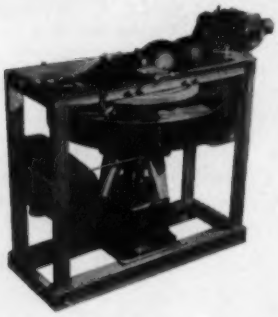
Which pilot plant filter do you need?



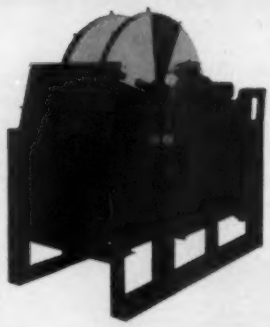
DRUM FILTER — String, scraper, roller, belt and precoat discharge can be tested on the extremely flexible FEinc Pilot Plant Drum Filter. Submergence washing and compression dewatering mechanism can be utilized if desirable. The 3 x 1 ft. size has 9.4 sq. ft. of filtering area and is constructed of Type 316 stainless steel. Smaller sizes available.

Eliminate the risk and unnecessary capital investment by scaling up from one of the seven Pilot Plant Filters offered by FEinc.

Available on a rental basis, these units allow you to determine optimum design and operation conditions for maximum filtering efficiency in your particular process. See our insert in Chemical Engineering Catalog, or write for bulletins or technical advice without obligation. Address Dept. MEF-261.



HORIZONTAL FILTER — FEinc can supply pilot models of both open and enclosed horizontal filters. 3 ft. diameter. Type 316 stainless steel. 7.6 sq. ft. filtering area.



DISC FILTER — FEinc Disc Filters for pilot plant work are also available. All FEinc pilot models are supplied with the filter cloth determined best for the application.

FE INC®

FILTRATION ENGINEERS DIVISION OF
American Machine and Metals, Inc.
East Moline, Illinois

Custom-designed continuous vacuum or pressure filters for better cake quality . . . lower costs . . . maximum filtering efficiency

Divisions of American Machine and Metals, Inc.

TROY LAUNDRY MACHINERY • RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS
NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC COMPANY • HUNTER SPRING COMPANY • GLASER-STEERS CORPORATION

(21) HARDINGE PLANT FACILITIES: To provide both its old customers and new ones with a picture of its modernized plant and the type of work it is currently handling, *Hardinge Mfg. Co.* has issued a 16-page pictorial review of its major manufacturing departments. Bulletin No. 101 covers the pattern shop, foundry, machine shops, plate steel work, and custom machinery, with tables listing the facilities within the shops. A discussion of Meehanite metal and Ni-Hard castings used by Hardinge Co. supplements the factory description.

(22) DUST BAGS: *The National Filter Media Corp.* has issued a four-page, illustrated leaflet entitled "Formula for Dust Collection" to describe its custom-designed dust bags. A comparative table of fabric properties is included for easy reference. The bulletin discusses some of the problems NFM has solved, such as inflammable dust and pressure drop vs. retentivity.

(23) TORQUE-FLOW PUMP: A four-page bulletin (P10-B44) describing the varied industrial applications of a non-clog Torque-Flow pump has been released by *WEMCO*, a division of *Western Machinery Co.* The bulletin uses applications in the coal, pulp and paper, and chemical industries to illustrate how the new design principle incorporated in the pump makes it completely non-clog, highly abrasion resistant, yet gentle enough to handle delicate materials without damage.

(24) SHAFT MUCKER: *Shaft & Development Machines Inc.* recently released a four-page illustrated brochure describing its air-powered Cryderman shaft mucker. It is designed for one-man operation in either vertical or inclined shafts. Specifications are provided for the two models available—"standard" (11 cu yd clam bucket) and "small" (5 cu yd clam bucket), with mucking capacities of 40.5 cfm and 20.3 cfm respectively.

FREE LITERATURE

(25) EXPLOSIVES AND BLASTING SUPPLIES: Bulletin No. 101 from *Trojan Powder Co.* describes the firm's line of high explosives. General purpose and special purpose explosives are discussed, as are primers and boosters. Tables providing cartridge counts on most types and sizes of cartridges in the Trojan line are included.

(26) MINE MAN CAR: *National Mine Service Co.* has published a four-page brochure describing its "ManKar" line which features speed, comfort, and safety. Developed by the *Greensburg Div.* of the company, the cars are powered either by self-contained batteries or by trolley wire, vary in capacity from 10 to 22 men, and range in height from 24 in. to 51 in. Other features include excellent visibility for the operator, rigid unit construction with heavy gauge steel plate, and ability to operate at high speeds without danger of derailment. Cars 30 in. or more in height employ a walking beam suspension to prevent teetering and to assure safe, comfortable rides.

(27) CONTINUOUS MINING MACHINE CABLE: Bulletin DM-5944 from *Anaconda Wire & Cable Co.* supplies data on a flexible, easily handled trailing cable which was job-designed for continuous coal-mining machines. Available for either a-c and d-c Type CCM cable is a combination of single conductors cabled into one unit for optimum heat dissipation and maximum load at no increase in cable weight. The new four-page leaflet includes tabular data on three available configurations color-coded for quick identification and maintenance.

(28) COAL LOADING MACHINES: Specifications and operating features of a new line of coal loading machines employing a unique double-arm gathering design are highlighted in an eight-page bulletin from *Long-Airdox Co.* The brochure illustrates operating advantages of the double-arm design and explains how "two-stage gathering" multiplies loading efficiency. Other advantages reported include savings on maintenance and parts inventory, better maneuverability, flatter head angle, and unusually good balance. Three models are available with loading rates to 12 tpm. The unit's design provides for all seam conditions and for heights as small as 23½ in.

(29) CRAWLER TRACTORS: Utility applications of the new H-3 and HD-3 compact crawler tractors are pictorially described in a new catalog (UT-130) recently released by the *Allis-Chalmers Mfg. Co.* The eight-page booklet gives information on the engineering, design, and construction features of the gasoline or diesel-powered crawlers. Also included are descriptions of matched equipment that increase the versatility of the crawlers.

(30) MAGNETIC TUBE TESTER: *Dings Magnetic Separator Co.* has issued a two-page bulletin which describes the Davis Magnetic Tube Tester. Included are specifications for both electromagnetic and permanent-type units, construction and operating details, and application data.

(31) ROTARY FEEDER: Bulletin F-8, a two-page flyer issued by *Fuller Co.*, describes and illustrates the company's newest rotary feeder in the field of dense stream conveying. The "Dual Air-Inlet DA Feeder" delivers and controls the feed rate of dry, pulverized, and granular materials in high pressure pneumatic conveying systems. The two-color bulletin includes dimensioned drawings and specifications for all sizes of DA feeders.

mail this post card for more information

2

Mining Engineering **29 West 39th St.** **New York 18, N. Y.**

Not good after May 15, 1961

Please send { More Information ☐ / Price Data ☐ / Free Literature ☐ } on items circled.

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11	12	13	14	15	16	17	18	19	20
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61	62	63	64						

Students should write direct to manufacturer.

(32) VACUUM DISC FILTERS: *Filtration Engineers Div.* of *American Machine & Metals Inc.* has released a four-page, two-color bulletin (No. 404) describing its continuous vacuum disc filters. Included in the brochure are diagrams of the "FEinc" disc filter; a chart showing the required area for standard disc filters; and details of the fabricated manifold, agitation methods available, and specially mounted scrapper blades to minimize bag wear.

(33) AIR COMPARISON PYCNOMETER: Advantages of using the Model 930 Beckman Air Comparison Pycnometer in conducting barite ore density measurements are explained in a new application data sheet published by *Beckman Instruments Inc.* The flyer, P-8071, explains and compares the two techniques for determining density of barite ores: the conventional Le Chatelier Flask procedure and the Air Comparison Pycnometer method. The main advantage of the Pycnometer is its ability to complete a barite density analysis in one to four minutes—in contrast to the Le Chatelier method which requires two to three hours. The data sheet also includes test results which show that determinations made by the Air Comparison Pycnometer are at least as accurate and reliable as those obtained by the Le Chatelier procedure.

(34) CENTRIFUGAL PUMPS: Circular No. 184, a 12-page selection catalog for users of their centrifugal pumps, has recently been published by *Dean Brothers Pumps Inc.* Included in this condensed circular are charts showing the recommended temperature and pressure ranges for ten classifications of the company's pumps. Illustrations, brief descriptions, and specifications are shown for each. For a copy, send your request on company letterhead **directly** to *Dean Brothers Pumps Inc., 323 West 10th St., Indianapolis 7, Ind.*

(35) TABLE OF CONVERSION FACTORS: A very useful wall chart containing approximately 400 conversion factors, including many that are difficult to locate in reference manuals, is now available from *Precision Equipment Co.* Of particular value to engineers, the 8½ x 11½-in. chart provides conversion units for electricity, heat, volume, weight, power, velocity, and area, plus dry and liquid measures.

(36) BUCKET ELEVATORS: A new 22-page booklet on industrial bucket elevators for the handling of bulk materials has been issued by *Hewitt-Robins Inc.* Bulletin No. 174 contains engineering data on various types of bucket elevators and recommends the grades of belting best suited for elevating materials of different weight, abrasiveness, temperature, and other characteristics. One section deals with belt selection procedures, another presents statistical tables on steel elevator buckets, and other sections discuss troubleshooting and belt splicing.

(37) WELDED STAINLESS STEEL SCREENS: *Bixby-Zimmer Engineering Co.* recently published a new 28-page brochure telling how the use of welded stainless steel screens can solve certain production problems in mining and ore preparation plants. Better dewatering, improved screening accuracy, sharper separation and prolonged screen life are some of the advantages cited. Also pictured are the special rod shapes which are now available, methods of screen mounting, special screen shapes and types, plus four pages of charts and tables containing pertinent technical data.

(38) SHUTTLE CARS: A new sales catalog G-148 recently issued by *Goodman Mfg. Co.* describes shuttle cars for use in low and intermediate height seams. The eight-page booklet explains design and construction features, and includes diagrams and specifications.

(39) WATER TREATMENT CHEMICALS: The chemistry of coagulation applied to effective water treatment in municipal and industrial plants, and practical approaches to solving treatment problems are discussed in the eight-page bulletin A-1, released by *Nalco Chemical Co.* Application of sodium aluminates; refined montmorillonites; cationic, anionic and non-ionic polymers; and a new concept of "Inline Clarification" are among processes described.

(40) TRACTOR-SCRAPER: Engineering and design details incorporated in the Caterpillar 619B-442 Tractor-Scraper team are discussed in a 12-page booklet recently issued by *Caterpillar Tractor Co.* The illustrated brochure includes specifications and detailed discussion of power, speed, safety and roadability, easy servicing and loading characteristics of the tractor-scraper unit.

(41) SAMPLE POLISHER: *Fisher Scientific* has issued a six-page bulletin describing the Vibromatic Polisher and explaining the vibratory polishing technique employed. Capable of handling 20 samples simultaneously, the unit can polish materials as soft as gold and as hard as boron. Sample sizes can range from 0.019-in. diam wire to 2-in. metal bars.

New Films

Float Your Troubles Away, a full color movie produced by *WEMCO* shows the heavy media process for removing unsound or deleterious particles from gravel. The theory, operation, and results obtainable in producing premium aggregate by this process are illustrated with case histories of three plants, two in the Midwest and one on the Pacific Coast. Available on free loan from Western Machinery Co., Sales Promotion Dept., 650 Fifth St., San Francisco 7, Calif.

The U.S. Bureau of Mines has produced an all-new version of *California and Its Natural Resources*, one of the most popular films in its motion-picture library. The new film is the third version of "California" to be circulated. It is a 16mm, sound and color film which runs 30 min. This version emphasizes the contribution of mineral and energy resources to California's notable industrial and economic progress. Sequences picturing mining operations, irrigation projects, petroleum production and forestry practices show how the state is developing and conserving its natural resources. Available on free loan from Graphic Services, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.

REALLY SHARP ON TURNS

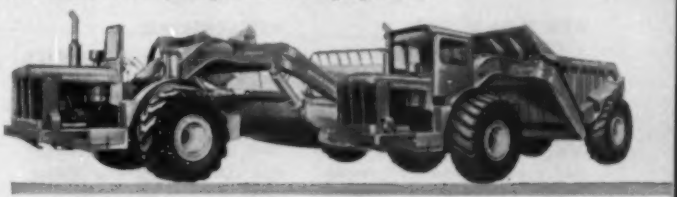
The all-hydraulic, 20-ton capacity TR-260 makes U turns in less than 26½ ft . . . saves up to 15 seconds per cycle over conventional haulers.

The 230-hp Allis-Chalmers TR-260 turns in less space than any wagon of comparable size. Complete U turns are made in less than 26½ ft. All-hydraulic, 2-stage steering with double-acting steering jacks gives you 2-way power pulling out of full turns. At the shovel and hopper, this kind of turning can save you up to 15 seconds per cycle over conventional haulers.

In addition, the sharp-turning TR-260 also gives you the benefits of KON-TORK *differential* and *plenty of tractor and wagon underclearance* to keep you on-the-go.

These are just a few reasons why the 20-ton capacity TR-260 brings you extra profits on your hauling jobs. Your Allis-Chalmers dealer will give you all the facts on both the TR-260 and the 12-ton capacity TR-160. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

You get double value and lower basic equipment investment when you use the 9.5-cu-yd TS-160 and 17-cu-yd TS-260, the 12-ton TR-160 and 20-ton TR-260 units. Both can be interchanged . . . together they eliminate need for specialized equipment.



KON-TORK is an Allis-Chalmers trademark.

move ahead with

ALLIS-CHALMERS

power for a growing world

NEW 631 420 HP (335 HP flywheel) . . . 31.2 MPH . . . 28 cu. yd. (21 cu. yd. struck).

NEW 630 420 HP (335 HP flywheel) . . . 41.5 MPH . . . 630A Tractor-Scraper . . . 28 cu. yd. (21 cu. yd. struck). 630-482C Tractor-Scraper . . . 35 cu. yd. (27 cu. yd. struck).

NEW ATHEY ROCK WAGONS
38 ton PR630 and PR631 built by Athey Products Corporation.

BIG! POWERFUL! NEW CAT 630 AND 631

MATCH POWER TO JOB CONDITIONS—AUTOMATICALLY!

A new concept in power shift transmission coupled with a new 420 HP engine . . . plus other proven new developments . . . provides the last word in operating, service, maintenance ease and economy. The four-wheel 630 and two-wheel 631 join the widely accepted DW20, DW21 and 619 to give you an even broader choice of hauling units from Caterpillar.

The new transmission and new engine on the 630 and 631 are designed and teamed to fit power to working conditions. This tailored power train, together with unit construction, greater scraper and wagon capacity, air-actuated cable control and new tires, makes the 630 and 631 the ultimate in hauling equipment design! Some of the features are described here. For complete proof of performance, ask your Caterpillar Dealer!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

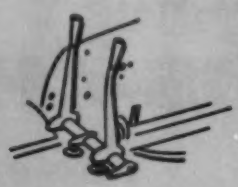
ADVANCED AS TOMORROW —CERTAIN AS YESTERDAY

NEW 29.5 x 35 TIRES
This all-new tire size was originally developed for the 630 and 631, to provide the best combination of size, capacity and rideability at lowest cost per yard. These tires were proven by exhaustive laboratory and field tests.

NEW SCRAPERS
Matching 28 cu. yd. heaped (21 cu. yd. struck) scrapers feature increased capacity, better loading. Sheave bearings now have 125-hour lubrication period. Other matching trailed units are also available.

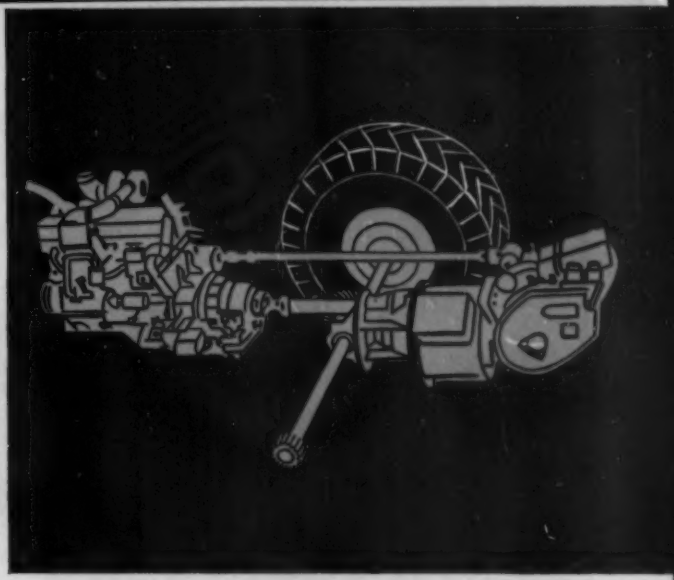
NEW CABLE CONTROL
Live power provides control whenever the engine is running. Air-actuated controls cut operator effort in half, yet retain "feel" of the control. New cable savers prevent breakage due to double-blocking.

IMPROVED STEERING
New two-jack steering makes the 631 easy to maneuver, yet retains "feel" of the road. Improved steering for the 630 absorbs shocks outside of the steering gear, provides easier handling in tight quarters.



SHIFT INDICATOR

SPEED RANGE CONTROL



3 SHIFTS—9 SPEEDS

POWER SHIFT TRANSMISSION. This new concept in power shift transmission automatically adjusts the 630 and 631 to job conditions. Key to this system is the torque divider transmission mounted directly behind the engine, which combines planetary gears with a torque converter so as to provide power to the three-speed-range transmission in one of three ways: (a) torque divider drive (a combination of 75% direct, 25% torque converter); (b) direct drive; (c) overdrive. Result: nine different speed variations—*but* the operator need only concern himself with the three speed ranges and load range controlled by one lever. (A safety latch prevents accidental engagement.) The rest is completely automatic, governed by a mechanical-hydraulic system. Here's how it works:

Operator moves lever into *1*, first range, to start machine down haul road. The machine is now in torque divider drive for easy start and greatest rimpull. As speed increases, converter is no longer required, so the transmission shifts *automatically* to direct drive. When conditions permit, it automatically shifts to overdrive. As speed increases, the shift indicator dial shows operator when to shift to second speed range, *2*. Again the transmission automatically goes into torque divider drive. As before, when conditions permit, it automatically shifts to direct drive and then to overdrive. This same cycle can be repeated in third range.

NEW 420 HP ENGINE AND MATCHED POWER TRAIN

Downshifting is automatic, too. As transmission senses increasing power needs, it shifts down from overdrive to direct drive to torque divider drive. When conditions require it, the indicator tells the operator when to select the next lower speed range. Once back in the cut, operator shifts to load position, *L*. This locks the transmission in torque divider drive of the first speed range.

ALL-NEW CAT ENGINE. Designed specifically for the 630 and 631, this six-cylinder, 5.4" bore x 6.5" stroke D343 engine is turbocharged and aftercooled. It develops 420 HP maximum (335 HP at the flywheel).

Typical of the newness is head design. The engine is parallel ported with dual intake and exhaust valves for most efficient air system. Overhead camshafts eliminate rocker arms and push rods. New shelf head design results in fast coolant circulation for outstanding heat dissipation.

In addition to these and other new features, the engine offers . . . the economies of the proven Cat fuel system with precombustion chamber (burns No. 2 fuel oil—premium diesel fuel not required) . . . pressure ratio controlled turbocharger for optimum air flow throughout the engine operating range . . . aftercooler for greater air density for more complete combustion.

FULL UNIT CONSTRUCTION—EASIER SERVICING

TRANSMISSION UNITS

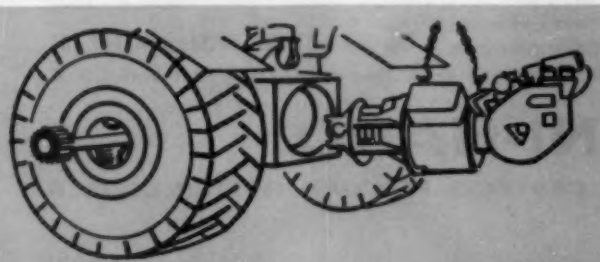
Range transmission is case mounted for accessibility, can be removed as a unit with cable control and differential carrier. Another timesaver: torque divider transmission is removable as a unit without disturbing the engine. Transmission control units are accessible without disturbing the transmission.

NEW RADIATOR-FAN UNIT

Fan is mounted on the radiator for more efficient cooling. Now radiator, side plates and fan can be removed as a unit for servicing—or to provide easy access to the front of the engine.

SERVICING TIMESAVERS

Dash swings away to expose entire left side of 631's engine. Crankcase guard pivots down for easy access to the bottom of the engine. For easy tire removal, rear fenders tip forward on the 630, and are easily removable on the 631.



Proof from Jones & Laughlin!

Ni-Hard liners keep their contour after grinding better than 2 million tons of ore

Here's photographic proof from the Benson Mine, New York Ore Division of Jones & Laughlin Steel Corporation in upstate New York.

Ni-Hard liners keep their contour — resist abrasion — provide a slow, uniform wear rate — are good to the last ¼ inch.

You could never tell by looking at them, but these Ni-Hard* nickel-chromium-iron alloy shell liners have been grinding iron ore *for more than 2 years.* With better than 2 million tons of ore behind them, they've still got plenty of tonnage left in them!

Used in J&L's ball mills and rod mills —at the feed end as well as the discharge end—these Ni-Hard liners are delivering *superior abrasion and wear resistance.* They're saving many thousands of hours of downtime, many thousands of dollars in repair and replacement.

Try a set of Ni-Hard liners and see for yourself how the abrasion and wear resistance of Ni-Hard can increase *your* tonnage, can lower *your* costs.

Our detailed 58-page booklet, "Engineering Properties and Applications of Ni-Hard" suggests many ways to put this versatile and long-lasting material to work profitably. Say the word and we'll be glad to send you a copy.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

NI-HARD®

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

Rise in Defense Metal Needs Predicted

The Interior Department has warned that defense requirements for 26 minerals and metals may climb well above current consumption levels, and nine metals will be needed in generous supply because of missile and space requirements. Latter metals include bismuth, columbium, hafnium, molybdenum, palladium, platinum, tantalum, tellurium, and titanium.

Sulfur Price Up $2 Per Long Ton

Domestic sulfur prices climbed to $22.50 per long ton, dark sulfur, and $23.50 per long ton, bright sulfur, f.o.b. Coatzacoalcos, V. C., Mexico. Pan American Sulphur Co. instituted the $2 per long ton increase shortly after producers set prices for export sulfur at up to $2.50 higher. Demand by foreign users of the yellow mineral climbed steeply with increased output of chemicals, synthetic fibers, and fertilizers. Although the U.S. still leads in sales abroad, an increasing portion of the growing sulfur market is being captured by France and Mexico.

Bunker Hill Strike Settled

A five-year wage contract terminated a seven and a half month strike at the Bunker Hill Co. operation in Kellogg, Idaho. Members of the Northwest Metal Workers Union will receive a 7¢ per hour increase immediately, 6¢ per hour in 1962, 6¢ per hour in 1963, and 5¢ per hour increases in both 1964 and 1965. The contract slates further pay increases should lead and zinc prices reach certain higher levels. The escalator clause provides that if the combined price of lead and zinc reaches the 28 to 29½¢ level and remains there for a period of at least two months, workers will receive an additional 3¢ an hour; at the 30 to 31½¢ combined price range, 7¢ per hour pay hike; and at the 32 to 34¢ level, 12¢ per hour.

Silver City and Deming Operations Reopen

American Zinc, Lead and Smelting Co. and Hydrometals, Inc. announced mining and milling operations at Silver City and Deming, N. M., were resumed on January 2. Explorations have been successful in indicating substantial tonnages of commercial grade zinc ore, and the operation now will be on a joint basis under the name American-Peru Mining Co. The Silver City district mines include the Kearney and Pewabic. The company mill, located at Deming, will ship its concentrates to the Dumas, Texas, plant of the American Zinc Co.

Kerr-McGee Acquires Kermac

Remaining outstanding common shares of Kermac Nuclear Fuels Corp. were acquired by Kerr-McGee Oil Industries, Inc. through an exchange of shares. Kermac Nuclear was holder of about 20 pct of all known U.S. uranium reserves and operated the nation's largest uranium mill, near Ambrosia Lake, N. M.

Bolivia Makes New Settlement Offer to Patino

The government-expropriated Patino mining group in Bolivia was offered a $6 million settlement by the Bolivian government, $2 million more than in previous discussions. The government has already made retention payments of some $8 million for the Patino companies, which include Patino Mines & Enterprises Consolidated, Inc., Bolivian Tin & Tungsten Mining Corp., and Compania Minera Agricola Aploca de Bolivia. The new settlement plan calls for payments to be spread over an eight-year period.

(Continued on page 118)

MINING engineering REPORTER

JOHNS-MANVILLE ADDS MILL TO EXPANDING PERLITE OPERATIONS

The No Agua mill at Johns-Manville's Seven Hills Property. Mill operation will be conducted on a year-round basis.

Perlite, a volcanic glass employed in the construction and chemical industries, is now being processed through Johns-Manville's new million-dollar No Agua mill northwest of Taos, N. M. This plant went on stream December 20 with a rated annual capacity of 150,000 tons. The new mill, coupled with the extensive perlite ore reserves and the blending and loading facilities in Colorado, make it the largest perlite mining, milling and blending operation in the industry.

The commercial use of the term *perlite* refers to any volcanic glass that will expand 4 to 20 times when crushed and heated in a range of 1400-1800°F. The expanded perlite product is lightweight (3 lb. to 15 lb per cu ft), vesicular, non-combustible granules. Used primarily as light-weight aggregate for plaster and concrete, its other applications range from additive in paints, paper, plastics and resins to a filtration medium for the food, chemical and pharmaceutical industries. It is also employed as a soil conditioner, loose-fill insulation, and as a major ingredient in rigid insulation roofing-board and other building materials.

The mill is a five-level, steel, concrete and corrugated asbestos-cement Transite structure containing more than 30,000 sq ft of operating space. A two-level building housing the dryer facilities is attached to the building, and nine elevated storage bins with a total combined capacity of 2150 tons of processed perlite are located adjacent to the mill.

Electric power is distributed at 440 v to provide the 800 hp required to handle the mill load. It was necessary in designing the mill to provide for a new 69,000-v power line from Questa, N. M., south to Taos, then northwest to The Seven Hills perlite deposit, an approximate distance of 50 miles. Two

300-Kw diesel generators, housed in a separate power plant adjacent to the mill, provide supplemental electric service when desired.

MINING AND MILLING OPERATION

The No Agua mill receives its ore from J-M's nearby Seven Hills mine, a "strip-rip-scrape" quarry operation, which taps the world's largest deposit of commercial-grade, uniform perlite ore. This 2000-acre property is located in "The Seven Hills of Taos", an historic site of ancient Pueblo Indian civilization. The volcanic beds are rhyolitic in composition, extend 500 to 600 ft below the surface, and are reported to contain enough perlite to last about 100 years at the anticipated rate of production.

The mining sequence begins with the removal of the 5-ft to 9-ft thick overburden, followed by ripping of the underlying bed of perlite. The exposed ore is then bulldozed to truck-loading "cribs" constructed below the mining level, and loaded into 18-ton capacity quarry trucks for transfer to stockpiles at the mill site.

Four steps of processing perlite are required before it is sent to the expanders— crushing, screening, separation of different grades of perlite, and blending of grades to consumer specifications. At No Agua, the ore passes through a 25x40-in. primary jaw crusher and is transferred by belt conveyor to a scalping screen. The smaller particles are fed to a bucket elevator emptying into a 100-ton surge bin. The larger fragments passing over the screen are sent to a 14x24-in. secondary jaw crusher, and then transferred by chute to the bucket elevator for dumping into the bin. Two constant feeders transfer the ore from the bin to two parallel, 6-ft diam, 50-ft long, rotary-type dryers.

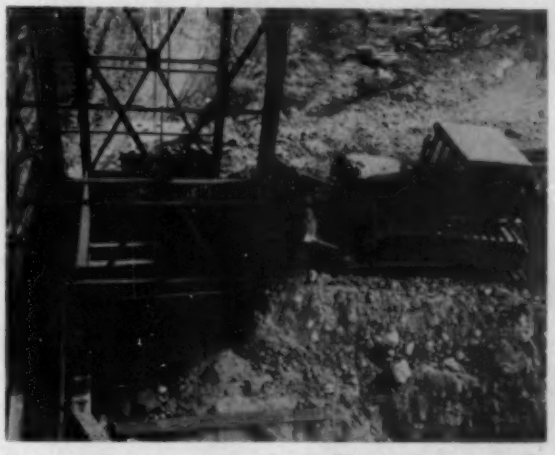
The dried ore is cooled on a vibrating conveyor to a second bucket elevator which dumps the ore onto a belt feeding a 4x8-ft scalping screen. All oversize is routed through a cone crusher for further reduction.

Both the ore from the cone crusher and the finer fraction from the scalping screen are sent to another vibrating conveyor which splits the ore into equal portions that are fed to one of the banks of primary, double-decked vibrating screens that separate granules into oversize, correct size or undersize.

The ore passing the first primary screens is directed to a bank of secondary screens for further grading. The oversize from this bank of screens is re-circulated through rod mills and sent to additional banks of primary and secondary screens. Any oversized ore is again re-circulated until all ore, except the granular size designated as "minus 30", is finally passed to the storage bins via conveyors. The "minus 30" portion is sent to the air-separators for classification into additional components and removal of the ultra-fines and dust.

View of the banks of double-decked vibrating screens. The entire reduction system is designed to permit maximum recovery of any standard commercial ore grade.

View of the crib-loading operation at the perlite quarry.



Ore from the quarry is first dumped by truck into a stockpile from which it is bulldozed into 25x40-in. jaw crusher.

In the final step of operations at the new mill, the graded perlite is loaded from the bins into trucks for transfer to J-M's Blending and Loading Plant at Antonito, Colo., 24 miles north of the No Agua mill, where each grade of perlite is unloaded into designated storage bins. The various ore grades are subsequently blended to meet the exact specifications of customers, who heat and expand the ore in their own facilities.

RESEARCH PROGRAM ANNOUNCED

The announcement of the beginning of operations at the No Agua mill was accompanied by the report that a research program has been initiated at the Johns-Manville Research and Engineering Center to determine the basic chemical and physical properties of perlite. This basic research, combined with their present program of industrial application investigations, may develop new uses for this versatile industrial mineral.

MINING engineering REPORTER

GE Announces Carat-Plus Synthetic Diamonds

Latest milestone in the General Electric Co. research and manufacturing work on synthetic industrial diamonds are large stones of more than a carat in size. So far the dark stones have structural imperfections and lack the mechanical strength needed for industrial uses, but the GE laboratories are already capable of turning out high-quality industrial diamonds up to 1/10 of a carat in size. In making its announcement, GE cited the uncertain conditions at the major source of natural diamonds, the Congo. Output in certain areas of the Congo was recently cut off for some months because of political strife and has only recently resumed.

Loan to Liberian Iron Ore Project

A $30 million credit was authorized by the Export-Import Bank for Liberian American-Swedish Minerals Co. The company plans to develop high-grade iron ore deposits in the Nimba mountains of Liberia in a joint venture with Bethlehem Steel Corp., which has a one-fourth interest in the project. Harbor and railway facilities are already under construction, and ore shipments are scheduled to begin in mid-1963. Output at the rate of 5 million tons annually is slated for 1964, and plans call for ultimately doubling that rate of production.

New Shaft Sinking Record

A new world's record for shaft sinking has been established at the Hartebeestfontein mine in the Union of South Africa. The feat: more than 1200 ft of 24-ft diam concrete-lined shaft in 31 days. The shaft area was grouted to depths of 1600 ft prior to sinking and much was removed by 14-ton-capacity buckets.

Base Metal Prices Cut

The quotations for both lead and zinc fell by 1¢ a lb in December, bringing the metals to 11¢ and 12¢ a lb respectively. Steadily climbing producer stocks, settlement of strikes, and lower prices on the London Metal Exchange all contributed to the declines. In a move to meet competition, St. Joseph Lead Co. is giving zinc buyers a $10 a ton discount—the equivalent of a ½¢ per lb reduction on the base price.

Venezuela Aluminum Facility Planned

The Reynolds Metals Co. international subsidiary and the Venezuelan government have agreed to form a joint, equally-owned company that will erect an aluminum reduction plant in southeastern Venezuela. The first primary aluminum plant in Venezuela, the unit will cost more than $30 million and is scheduled to have an initial annual capacity of 25,000 tons of metal.

Mohole Test Drilling to Start in April

Project Mohole, the drilling plan to penetrate the Mohorovicic Discontinuity, will enter its first stage when test drilling begins in April at a site in the Pacific near Guadalupe Island, off the west coast of Mexico. The ship-mounted drill rig must send a 9-in. diam stem down through 2.3 miles of ocean water before drilling can commence. Conventional anchoring is impossible, but two motors will be used on each side of the ship to prevent drifting. Actual drilling to reach the Moho, which separates the earth's crust from its mantle, may not begin for several years and will probably be done from another site.

THE STEEPER THE GRADE...

the more "extra" loads a cycle-gaining Payhauler® gives you

Of all three 27-ton off-road haulers, only the International 95 Payhauler gives you the weight-shedding, strength-multiplying advantages of the rock-ribbed, corrugated body. Only the "95" is plus-powered by the 375-hp DT-817 turbocharged Diesel. And only the "95" gives you an exclusive combination of power-control, safety, and comfort features that turns haul-speed advantages into extra haul-cycles! *Prove to yourself* what comparative grade charts and work-tally sheets show! See your International Construction Equipment Distributor for a Payhauler demonstration!

Positive Torqmatic braking gives the operator complete control of this fully-loaded "95"—builds confidence to use the highest practical haul speeds, even when hauling down the steepest grades. "One-hand" power-steering teams with finger-tip brake lever control to give course-holding, grade-matching downgrade hauling stability. Torqmatic braking, standard equipment on the power-shift "95," is a Payhauler *plus*—furnished in addition to the standard, internal-expanding wheel brakes—to help give you "*extra*" loads on tough hauls!

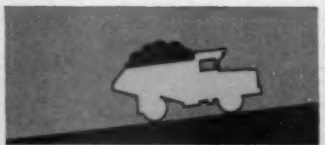
Grade charts prove: only the 95 Payhauler delivers

Total grade and rolling resistance, 10%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	10.2	
Competitor X	8.0	27.5%
Competitor Y	8.0	27.5%

Total grade and rolling resistance, 11%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	10.1	
Competitor X	7.0	44.3%
Competitor Y	7.5	34.7%

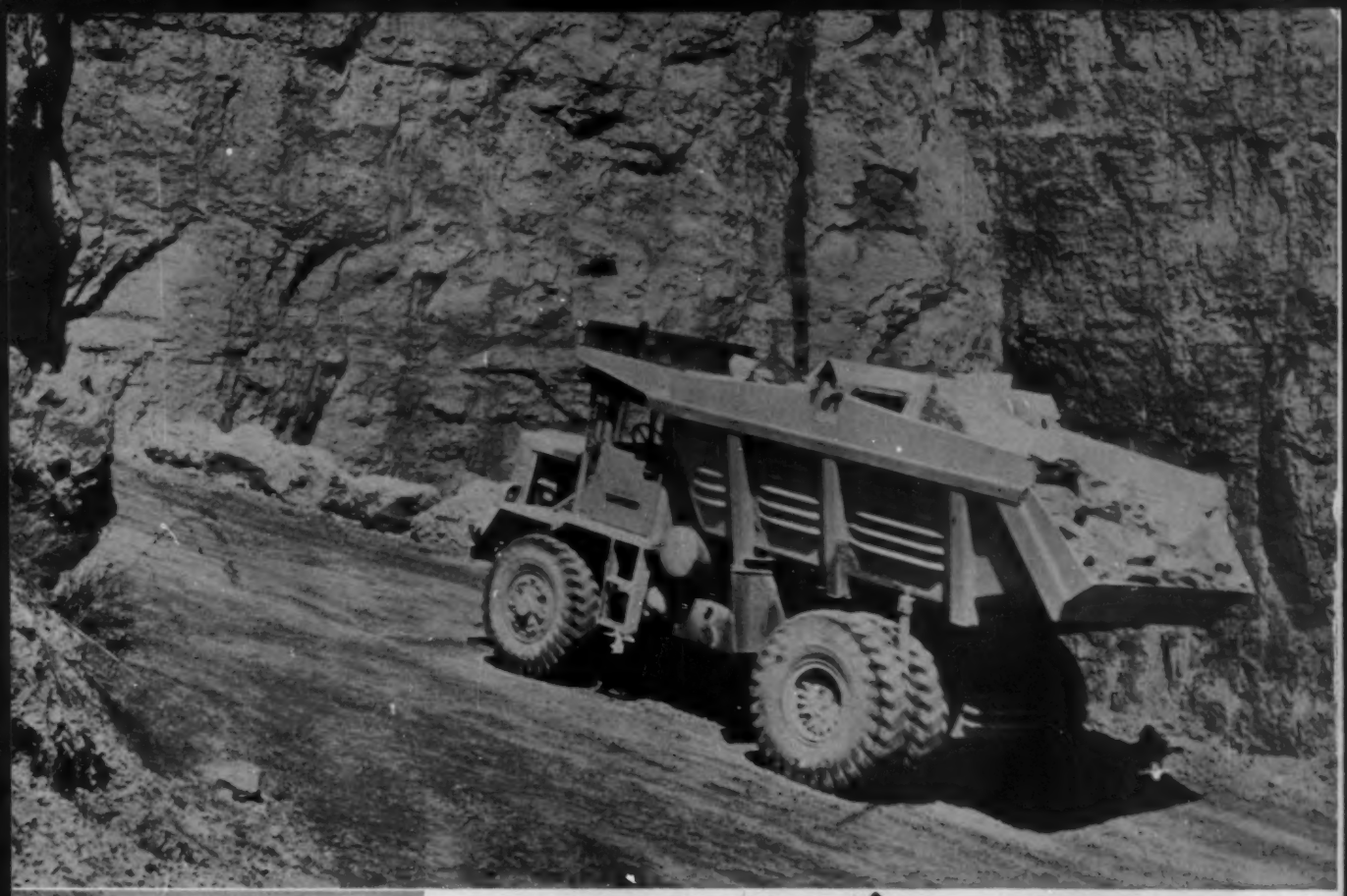


Total grade and rolling resistance, 12%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	9.0	
Competitor X	6.3	42.9%
Competitor Y	7.0	28.6%

Total grade and rolling resistance, 13%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	7.9	
Competitor X	5.5	43.6%
Competitor Y	6.0	31.7%



Two 65 Payhauler rigs speed full 19-ton loads of dolomite from quarry to crusher—up a maximum climb-out grade of 16%. Powered by the 250-hp naturally aspirated "817" Diesel—equipped with weight-shedding corrugated steel body—the "65" consistently hauls 30% faster than competitive rigs! Price the "65"—you pay less per hp, less per struck yard and per ton of capacity than for competitive rigs!

Three 95 Payhauler trucks replace five competitive haulers in a large Chicago-area quarry. Reasons: fully-loaded "95's" haul upgrade as much as 44% faster than the competitive make—give fast, "big-target" lodding—dump in only 11 seconds with exclusive power-up and power-down hoist action. And the cycle-gaining "95's" with Torqmatic power-braking, power-steering and power-shifting deliver "extra" loads on steep hauls!

International Harvester Co.
180 North Michigan Ave.
Chicago 1, Illinois

A COMPLETE POWER PACKAGE

International® Construction Equipment

"extra" loads . . . over any 27-ton competitor

Total grade and rolling resistance, 14%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	7.2	
Competitor X	5.0	44. %
Competitor Y	5.5	30.9%

Total grade and rolling resistance, 15%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	6.4	
Competitor X	4.8	33.3%
Competitor Y	5.3	20.8%

Total grade and rolling resistance, 16%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	5.8	
Competitor X	4.6	26.1%
Competitor Y	5.0	16. %

Total grade and rolling resistance, 17%

Hauler	Hauling Speed (mph)	Payhauler Advantage
95 Payhauler	5.4	
Competitor X	4.5	20. %
Competitor Y	4.9	10.2%

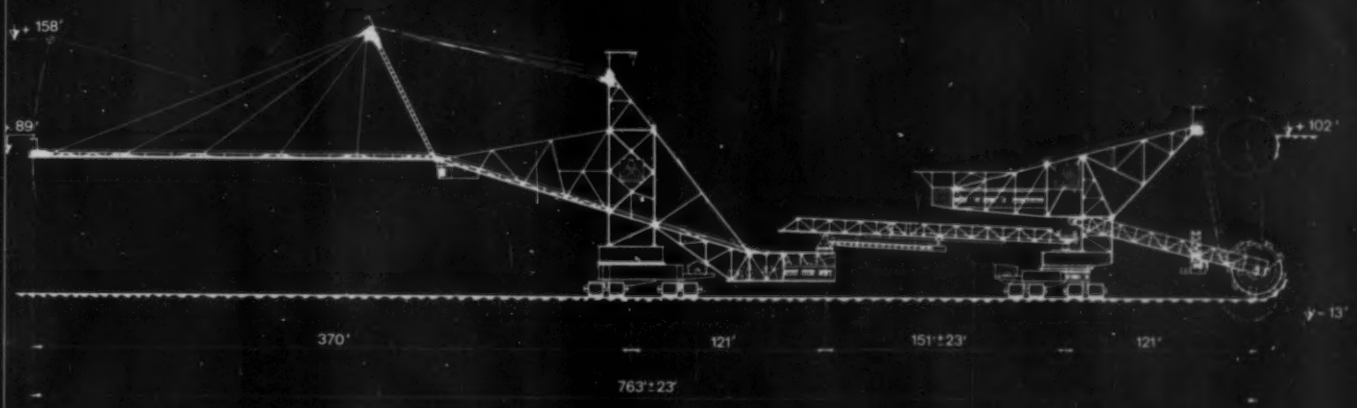
Krupp Bucket Wheel Excavator and Boom Stacker

strip-mining the lignite deposit of Arjuzanx (France). Bucket Wheel and Stacker are crawler-mounted and connected by a telescopic conveyor bridge. This combination enables an economical mining of thin lignite seams covered by relatively thick layers of overburden, whilst ensuring a large width of uncovered lignite reserve of approx. 215 ft.

Maximum cutting height: 102 feet
Output: 1960 cu.yds. of solid soil per hour
Length of discharge boom: 370 feet
Overall length of plant: 786 feet
Year of build: 1959
Purchaser: Electricité de France

FRIED. KRUPP MASCHINEN- UND STAHLBAU RHEINHAUSEN

For information, please contact Krupp International Inc., 375 Park Avenue, New York 22, N. Y.



7839

TGS....

RAIL AND WATER SHIPMENTS

In order to better serve our far-flung customers in the process industries, we have developed at Beaumont, Texas the most modern Sulphur storage, handling and loading facilities in the world. This terminal and shipping center is now receiving deliveries from all four major TGS properties in Texas: Spindletop, Moss Bluff, Newgulf, and Fannett - the most recent mine to be developed.

. . . . is now operating at **Beaumont, Texas**

THE WORLD'S NEWEST SULPHUR TERMINAL

. . . for Solid Sulphur

. . . for Molten Sulphur

A few of the design features of this terminal may be of interest:

- **It receives, stores, and loads both solid and molten sulphur.**
- **It can load simultaneously 1 dry cargo ship of 20,000 tons capacity, 3 molten sulphur barges and 1 molten sulphur tanker. There's a holding dock where a second cargo ship can be tied up. The barge basin will accommodate 12 sulphur barges.**
- **Storage capacity totals 31,000 tons for molten sulphur and 1,000,000 tons for solid sulphur. Loading capacity for molten sulphur ranges up to 3,000 tons/hour, tanker and barge simultaneously; for solid sulphur the loading capacity is 1,200 tons/hour into ship or barge.**

This development at Beaumont is but another step in the broadening delivery service program now being carried out by TGS. Regional distribution centers, handling molten sulphur, are already in operation at Cincinnati, St. Louis and Tampa. Coinciding with the full operation of our main terminal at Beaumont will be the opening early in 1961 of two coastal terminals at Carteret, New Jersey, (26,000 tons molten sulphur storage) and Norfolk, Virginia (20,000 tons). Other terminals are in the planning stage.

TEXAS GULF SULPHUR COMPANY
75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas
Sulphur Producing Units: **Newgulf, Texas • Spindletop, Texas Moss Bluff, Texas • Fannett, Texas • Worland, Wyoming • Okotoks, Alberta, Canada.**

HOW TO SIMPLIFY PIPE LINE INSTALLATIONS

NAYLOR Wedgelock couplings make a positive connection, securely anchored in standard weight grooved ends.

To help you get the job done faster, easier and more economically, NAYLOR offers a pipe and coupling combination to simplify pipe line installations.

The characteristic lockseamed, spiral-welded NAYLOR structure gives you pipe that is light in weight without sacrifice of strength and safety. It's easy to transport, handle and install. You save time, trouble and money right down the line.

NAYLOR Wedgelock couplings fit into this economy picture, too. They simplify and speed connections since a hammer is the only tool required to connect or disconnect them, and joints can be made up with only one side of the pipe in the open.

Whether it's air, water, tailings or ventilating service, it will pay you to look into this dependable combination.

Write for Bulletin No. 59

NAYLOR PIPE *Company*

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CYANAMID

Reagent News

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Blasting Agents
Blasting Caps
Electric Blasting Caps
Blasting Accessories

Now commercially available . . .

AEROFLOAT® 194 Promoter

New Cyanamid general-purpose sulphide promoter!

A recent development by Cyanamid's Mining Chemicals Laboratories, this new water-dispersible flotation promoter has already proven itself in a six-month plant scale trial at a leading U. S. copper operation. Plant results have confirmed its early promise as an effective and selective metallic copper and copper sulphide collector in LPF (leach-precipitation-flotation) circuits at acid pH levels.

While AEROFLOAT 194 Promoter is a liquid with many of the properties of older-type oily promoters, it may also be mixed with water to make a 5% or 10% solids dispersion for closer control of feeding. Or, it may be fed undiluted to the flotation, grinding circuit or conditioners. AEROFLOAT 194 Promoter has also shown promise as an auxiliary promoter in combination with AERO® Xanthates or other AEROFLOAT Promoters.

Successful use as a copper collector has encouraged investigation of AEROFLOAT 194 for flotation of other sulphide minerals. Results have been quite encouraging on lead and zinc ores. Effective dosage rates range from 0.01 to 0.2 lb/ton of ore. If you would like to evaluate its possibilities in your mill, get in touch with our nearest office for working samples and a technical data sheet.

AMERICAN CYANAMID COMPANY
EXPLOSIVES AND MINING CHEMICALS DEPARTMENT

CYANAMID INTERNATIONAL — *Mining Chemicals Department*
Cable Address: — Cyanamid, New York

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

International Nickel Selected Marcy Mills for its new Levack Plant

Inco's new 6000 ton per day Levack Mill, in the Sudbury district of Canada, features extensive use of automatic and remote controls designed for maximum efficiency to offset rising costs.
The company states that: "The experience gained from its Copper Cliff and Creighton mills, operating since 1930 and 1951 respectively, proved of great value in designing the Levack Mill." Marcy Mills are used at both Copper Cliff and Creighton.

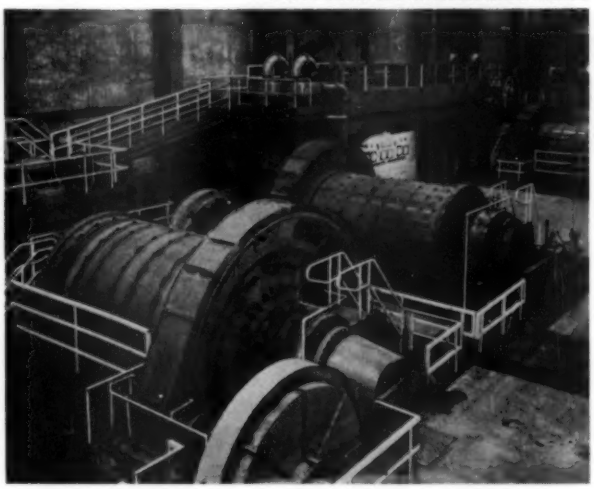
INCO HAS PURCHASED A TOTAL OF 61 MARCY MILLS

International Nickel Company of Canada, Ltd., world's largest producer of nickel, has purchased a total of 61 Marcy Mills including the four at Levack.

TYPICAL EXAMPLE OF MINE AND SMELTER'S WORLDWIDE SERVICE

Canadian Vickers, Ltd., Montreal, Mine and Smelter's sales agent and licensed manufacturer for Marcy Mills in Canada, in cooperation with International Nickel and Mine and Smelter, manufactured and serviced the Marcy Mills for Levack.

PHOTO COURTESY INTERNATIONAL NICKEL



LEVACK MILL. Photo shows one of the two grinding sections. Each section includes one 10' x 15' Marcy Rod Mill and one 10' x 14' Marcy Ball Mill. Central instrument panel controls entire grinding operation.

THE STRENGTH OF A BELT IS IN THE CARCASS!

and

Scandura

SOLID WOVEN PVC

has the highest tensile carcass of any belting in the mining industry

Results:

- PROVED SERVICE RECORD!
- NO FASTENER PULL-THROUGH!
- LONGEST CENTERS!
- UNEQUALLED TOUGHNESS!

It's an easily-demonstrated fact: SCANDURA has the strongest, most densely-woven carcass of any solid-woven or ply-type belt. This superiority serves you best in *every* measure of belting performance—dollar by dollar, year by year! Your National Mine man has the facts. *Call him.*

550 feet per minute is normal for SCANDURA on this rope conveyor

National Mine Service Company

Koppers Building Pittsburgh 19, Pa.

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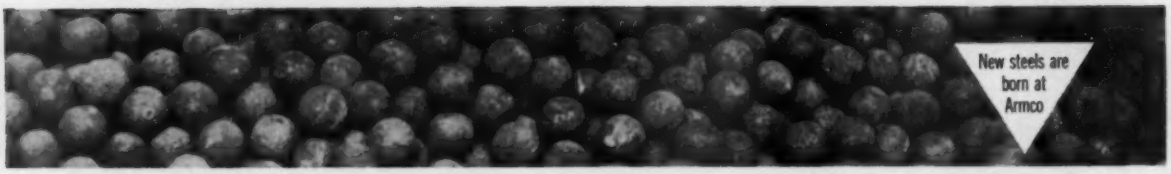
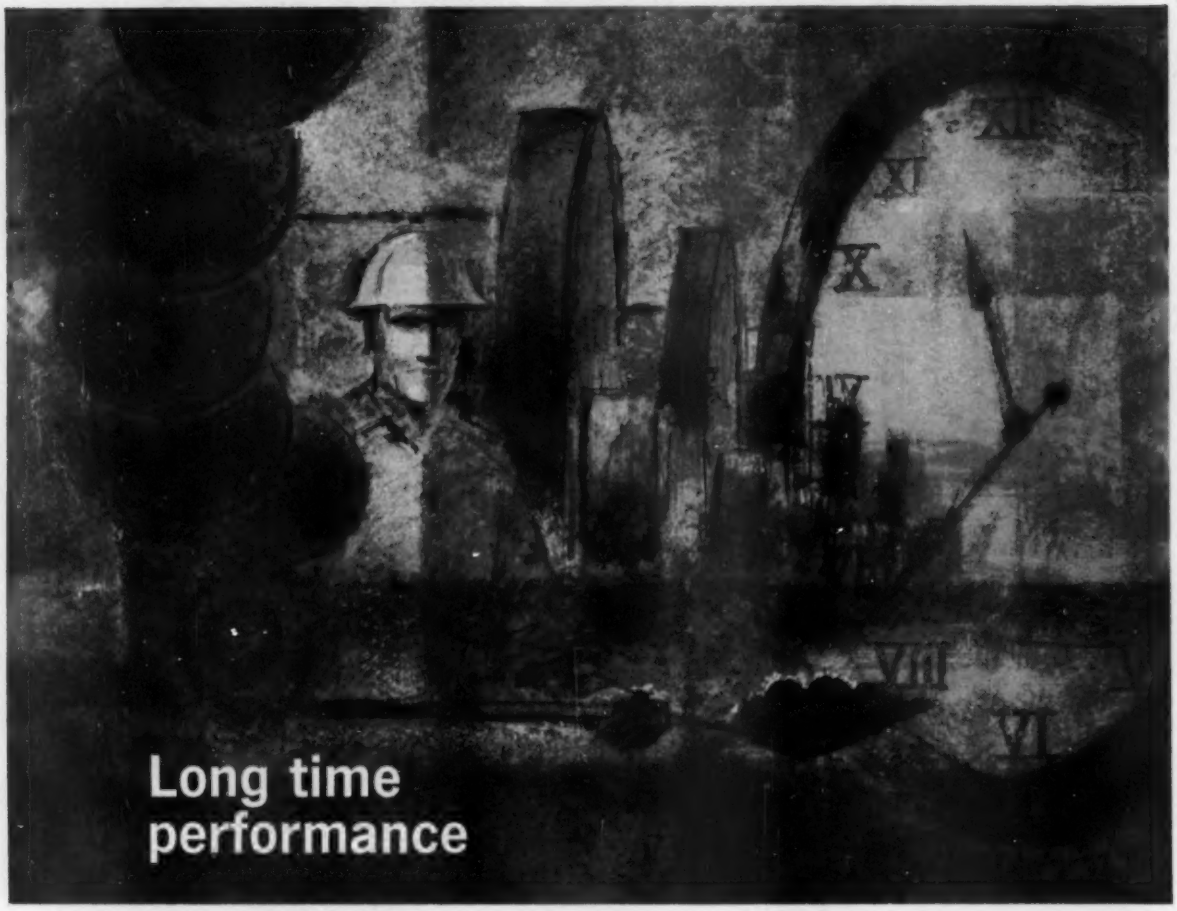


SHEFFIELD MOLY-COP Grinding Balls

COPPER-MOLYBDENUM-ALLOY



has earned customer acceptance

More than a million tons of Sheffield Grinding Balls, used in every kind of grinding job, have performed with dependability around the world. Top performance can be expected from Moly-Cop because Sheffield alloying, heat-treating and forging are kept consistently uniform by Sheffield constant quality control. Result: Moly-Cop Balls retain their sphericity longer, to give a better grind at lowest cost per ton. The Standard of Comparison Around the World. **Sheffield Plants: Houston, Kansas City, Tulsa**

ARMCO Sheffield Division

Jeffrey Type 97 Crawler Loader delivers up to 35 tons of payload per minute

The rugged Jeffrey Type 97 Crawler Loader has been developed to meet the problems of loading in high seam mines. It is a fast, easily maneuverable, high capacity loader rated to handle 21 TPM of coal or 35 TPM of salt.

Seven electric motors power the Jeffrey Crawler Loader; two drive the gathering arms, two are used for tramming, two provide a separate drive for the conveyor, and one is used to power the gear pump that supplies oil to elevate and swing the discharge conveyor and raise and lower the gathering head.

The Jeffrey Type 97 Crawler Loader is produced in two basic models. Type 97-A is designed specifically for loading coal. Type 97-B is designed to load salt, gypsum, or other similar materials. Standard heights of the Loaders are 43″ and 48″.

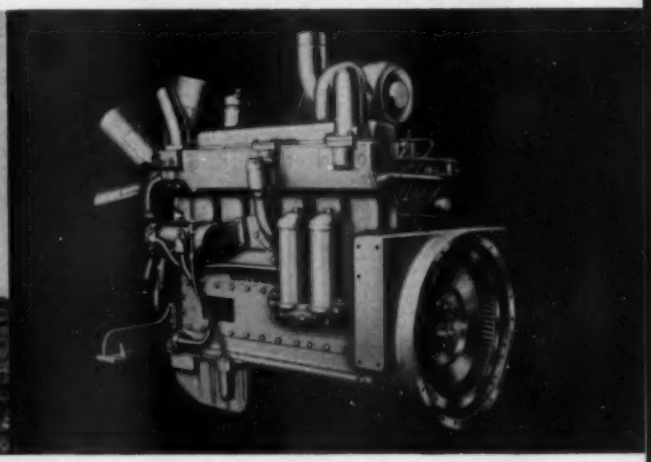
For detailed information about either model of the Jeffrey Type 97 Crawler Loader, write The Jeffrey Manufacturing Company, 865 North Fourth Street, Columbus 16, Ohio.

Mining • Conveying • Processing Equipment... Transmission Machinery... Contract Manufacturing

JEFFREY

NEW CAT NO. 14 SERIES C MOTOR GRADER

Compact engine plus many other refinements assure top performance, easier servicing, long life



Important changes make up the new Series C No. 14 Motor Grader—big improvements throughout to give you better performance, long life and servicing ease:

NEW COMPACT 150 HP ENGINE The short, rigid block and stress-relieved crankshaft give greater strength and shock resistance. New cylinder head design resists distortion yet has superior cooling characteristics. Large water pump with cast-iron impeller, ceramic seal face, and carbon type seal combined with a 20 per cent increase in radiator capacity improves cooling, lengthens life.

NEW STARTING ENGINE All-weather starting with this new two-cylinder vertical gasoline engine is assured. Replacing the horizontal engine, this design features aluminum pistons and overhead valves for improved performance. Bore is 2.38″, stroke is 2.38″, and compression ratio is 8:1. Over-running clutch in starter pinion prevents damage to starter engine when diesel starts, a year-round starting plus.

NEW SERVICING EASE An advanced fuel system is designed for easier servicing and more efficient operation. Compact fuel injection pumps with barrel and plunger assemblies enclosed in housing help reduce wear, lengthen service life.

Plus all the features that made the No. 14B the most versatile motor grader in the "big machine" field . . .

EXCLUSIVE OIL CLUTCH —provides up to 2000 hours of service without adjustment, equal to about a year of "adjustment-free" operation.

DRY-TYPE AIR CLEANER —removes 99.8 per cent of all dirt from intake air. Can be serviced in five minutes.

MECHANICAL CONTROLS —provide easy engagement. "Anti-creep" lock makes blade stay put under load.

FULL VISIBILITY —operator has unobstructed view of job even while seated.

Now, all Cat Motor Graders feature the compact engine. Like the new No. 14C, the 85 HP No. 112E, the 100 HP No. 112F, and the 115 HP No. 12E are all designed to give you the highest production at the lowest possible cost. Your Caterpillar Dealer can give you the facts and figures. He can prove it both on paper and on your job. Call him today.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

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THE NEW NO. 14C
MOTOR GRADER—
MADE FOR THE BIG JOBS

MINING engineering **DRIFT**

PROGRESS AND/OR PROSPERITY

The year 1960 will go into the record books under varied headings. For the overall economy, one viewed with alarm or pointed with pride, depending upon your political alignment. Economic forecasters, and those other forecasters who did not pick Pittsburgh, took a beating. Business levels were paradoxically high and disappointing. For example, the dollar value of mineral production reached a level second only to 1957, but many were upset because this performance was below original expectations.

But the effect of immediate economic conditions is short-term. What about the long-term basic health and vitality of the mining industry? There is encouraging interest in two things: marketing and research.

Marketing: The products of the mining industry are meeting increasing competition, both internal and external. What is encouraging is that we see the most affected segments of the industry—copper, lead, and zinc—working toward better and greater utilization of their products. This is vital for the future, because its fairly obvious that if you cannot sell something there is little point in producing it. Market research, product research, and product promotion are some of the tools being mobilized to fight inroads made by non-mineral materials and the aggressive newer metals. Good.

Research: Efforts in mining research are still best described as sporadic, individual, and under-financed. But good work is being done and more will be done each year if the present attitude toward that research continues and grows. In research, at least, understanding preceeds creating, and in many fields mining researchers are still at the stage of developing means of measurement, tools for research, and trying to isolate the forces at work. Encouraging results so far in drilling, blasting, and rock mechanics should therefore be but an indication of ultimate gains. Again, this is a good omen for the long haul.

For comment on a third important trend, that in mining education, please see below. *R. A. B.*

OUT OF THE FLAMES

The SME Education Committee Session at the 1960 AIME Annual Meeting had for its title *Mining Engineering Education —Phoenix or Dodo?* A distinguished panel dealt bluntly with this topic. There was general agreement that mining engineering education is truly a live issue. There was agreement that current curricula leave much to be desired. There was also agreement that the needs of industry and the objectives of education need periodic reappraisal.

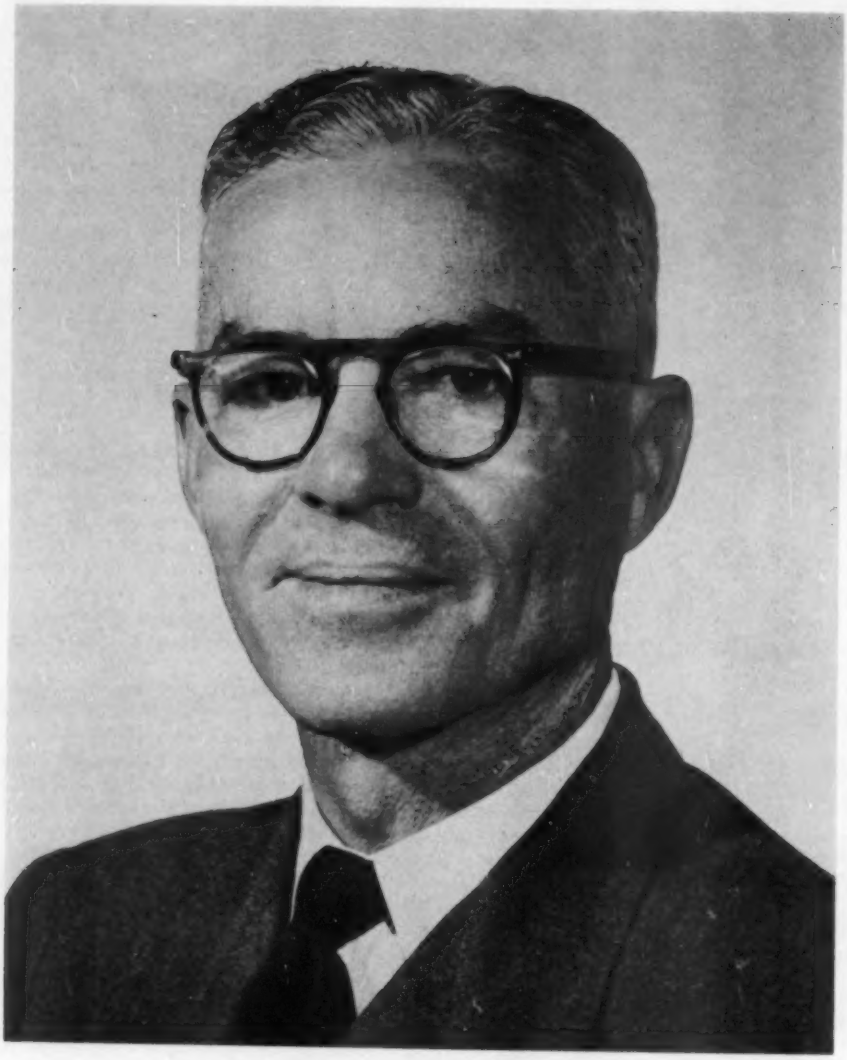
The program to be presented at St. Louis is just such a reappraisal and will lead to momentous conclusions and real action.

Alvin W. Knoerr, Editor, *Engineering and Mining Journal*, will report on "What the Mining Industry Expects of an Engineer."

Evan Just, Head, Department of Mining Engineering, Stanford University, will present "The Educator's Viewpoint."

John J. Reed, Professor, Colorado School of Mines, will examine the problem "How to Provide Research for the Mineral Industries."

This session will be held in the Zodiac Room atop the Chase Hotel on Sunday, February 26, 1961, from 2:00 pm to 5:00 pm. The presentations—and the discussion they are bound to provoke—will make it well worth *your* while to attend.—*J. C. F.*



Ronald R. McNaughton

1961 AIME President

R. R. McNaughton

R. R. McNaughton assumes the AIME Presidency for 1961 after many years of active service in North American professional groups. Metallurgical Div. Manager for the Consolidated Mining and Smelting Co. at Trail, British Columbia, he is the first Canadian ever to be elected President of AIME.

Determined effort within the sphere of his profession has dominated Mr. McNaughton's career since joining Cominco at Trail in 1924, immediately after being awarded a B.Sc. degree with honors in metallurgical engineering from McGill University at Montreal.

He has held a series of posts with Cominco in the Metallurgical Div., becoming manager of the Division in 1946. The operations under his direction include lead, zinc, and silver plants which are among the largest in the world and presently employ about 1800 people.

In earlier years with Cominco, Mr. McNaughton was in charge of research and development on a number of projects in the Smelting Dept. including the slag fuming operation, constructed in 1930, which is still the largest operation of this kind. He has been closely associated with the many plant expansions and, more recently, he has been directly responsible for the extensive modernization programs carried out in Cominco's large lead and zinc production facilities.

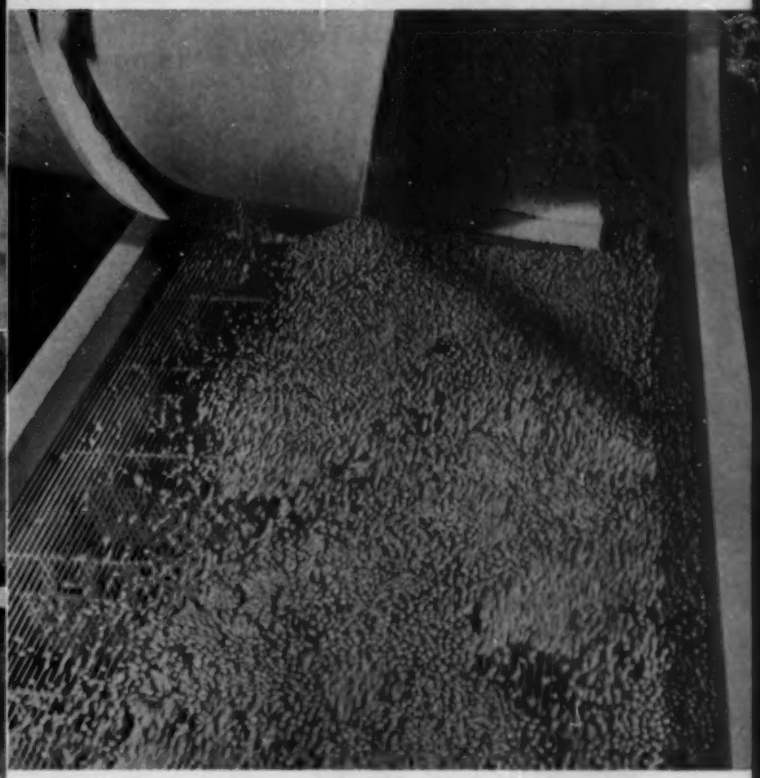
His position with Cominco and his activities with professional groups leave little extra time in Mr. McNaughton's day. In addition to his active association with AIME, he is also a member of the Canadian Institute of Mining and Metallurgy and the Association of Professional Engineers of British Columbia. Prior to being elected AIME President he held numerous offices in the Institute, including that of Chairman of the Extractive Metallurgy Div., and Chairman of the Metals Branch (now The Metallurgy Society of AIME). He has also been a Director of AIME.

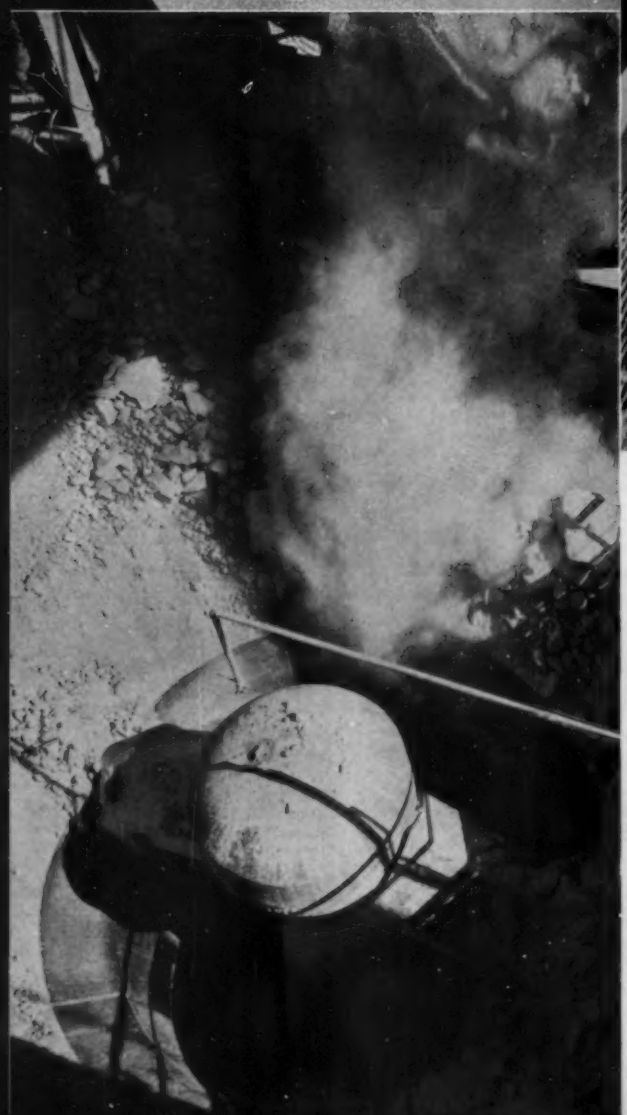
Although Mr. McNaughton's interests are mainly centered on his professional associations, he finds time in the summer months to play golf, his favorite recreational activity. In his younger days he was a better-than-average violinist, and as a bachelor during his first few years at Trail, he formed part of a "bunkhouse orchestra" that served to brighten the off-hours.

Mr. McNaughton is married to the former Dorothy Millen of Montreal, and has two married sons, Richard and Peter.

From low-grade ore . . . ideal blast furnace feed: Now processing 1000 itpd of beneficiated, finely powdered concentrates from low-grade iron ore, the new Grate-Kiln system produces these iron-rich pellets. Easy to ship and ready to use as blast furnace charge, these pellets are also economically produced. Costs are kept low by a unique system of heat recovery and process control.

Keeping pellets optimum sized: Installed as part of the first Grate-Kiln system used for iron ore processing, this specially-designed A-C vibrating screen "sizes" pellets from the Allis-Chalmers balling drum, permits only properly sized balls to pass to the system for heat processing. Years of experience in handling screening problems like this have resulted in a wide range of screen sizes and features.





Rugged primary gyratory crusher: This 60-inch Superior gyratory crusher crushes tons of hard, abrasive ores daily — proof of its tough construction. But, in addition, this machine requires no downtime for resetting to compensate for mantle and concave wear. The Hydroset control, exclusive with A-C cone and gyratory crushers, permits instantaneous wear — compensating adjustment while in operation.

A-C INDUSTRIAL EQUIPMENT DIVISION: motors, generators, controls, rectifiers, pumps, compressors, crushers, mills, screens, kilns, coolers, industrial systems.

OTHER A-C PRODUCTS: thermal, hydro and atomic electrical generating equipment; switchgear, transformers, unit substations; tractors, earth-moving equipment, engines, lift trucks.

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are engineered for mining

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For extremely hard abrasive rock
(Taconite, quartzite)

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For hard rock
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(Limestone, sandstone, sandy shales)

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Faster blast-hole drilling means more production, lower costs. In areas where blast hole drilling is the toughest, Hughes "Rota-Blast" rock bits and rotary drilling techniques, developed in close co-operation with operators and drill manufacturers, are increasing footage and penetration rate 100% and more.

Your Hughes representative can recommend the "Rota-Blast" bit best suited to your operation, and is also qualified to offer you assistance in your drilling program. Back of his recommendations and the bits he sells are more than a half-century of specialized rotary rock bit experience, and the world's largest rock bit manufacturing plant.

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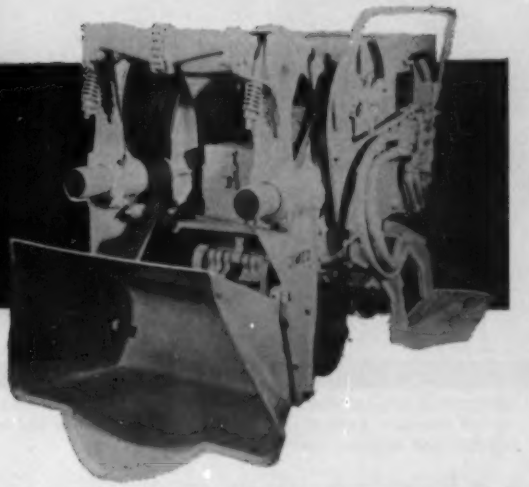
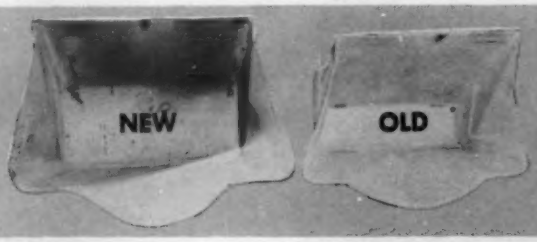
New! Improved!

The EIMCO Rocker Shovel 24 Loader



From Eimco, world's largest and foremost manufacturer of underground rock loading equipment . . . a completely re-engineered, re-designed and greatly improved successor to the famous Eimco 21 Rocker-Shovel Loader . . . the EIMCO 24.



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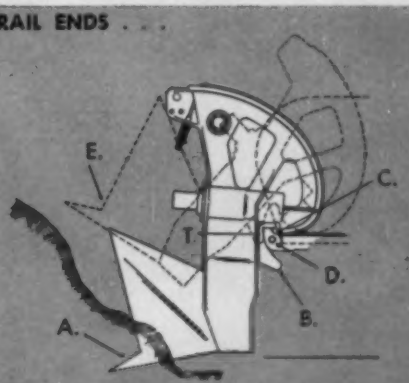
BUMPER SPRINGS IN ARMS . . .

Patented arrangement of bumper springs enclosed in cylinders within arms, for trouble-free long life, increased machine stability, no sacrifice of machine length or bucket discharge distance.

PATENTED INVOLUTE RAIL ENDS . . .

A. Bucket Down Position
B. Arm Thrust Liner
C. Rail End
D. Patented involute rail ends maintain contact (at 'T') between arm and rail end and provide positive thrust support throughout digging and crowding portion of bucket cycle. Crowding forces are taken by rail end and arm thrust liner, instead of being imposed on arm cables, for greater force, longer life.
E. Bucket raised through the muck pile where thrust is no longer required.



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Expanded range of discharge heights.
Greater digging force and increased bucket cleanup width.
Improved discharge distance for better loading of long cars.
Provision for digging below depth of rails, for ties.
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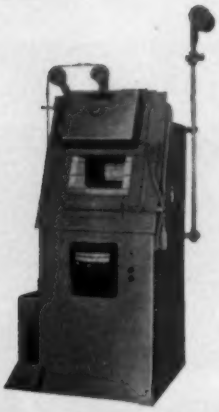
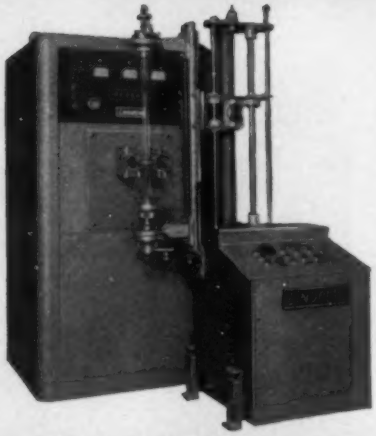


Low Temperature Furnace for solar cells and treatment of metals.



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We can engineer and produce refractory designs and mixes—dishes, boats, crucibles of zircon, zirconia, alumina, pure oxides, etc., for specific needs.

High Temperature Crucible Pot Furnace for melting. Maximum temperature 1600°C.

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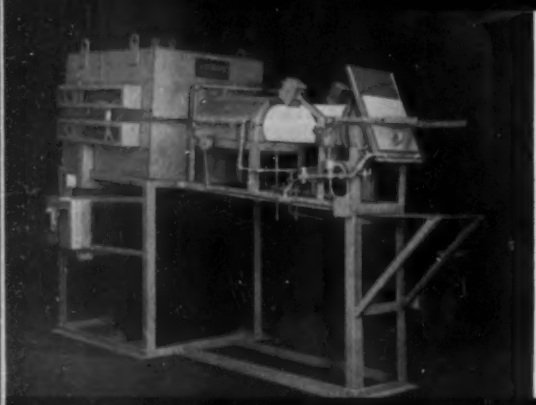
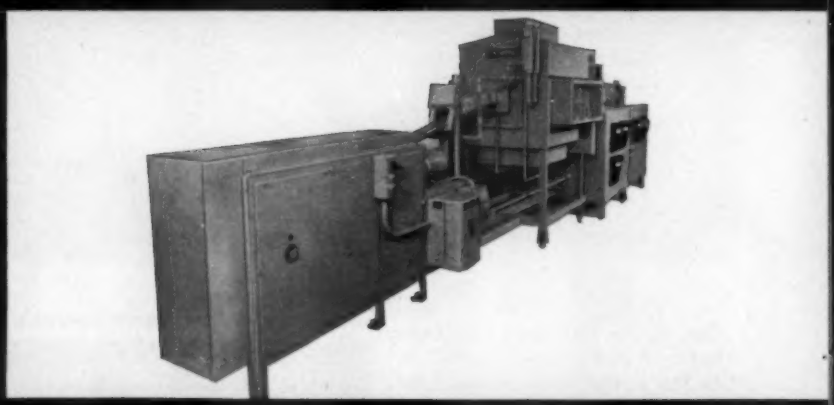


Hydrogen Atmosphere Furnace for reduction of germanium oxides and other materials.



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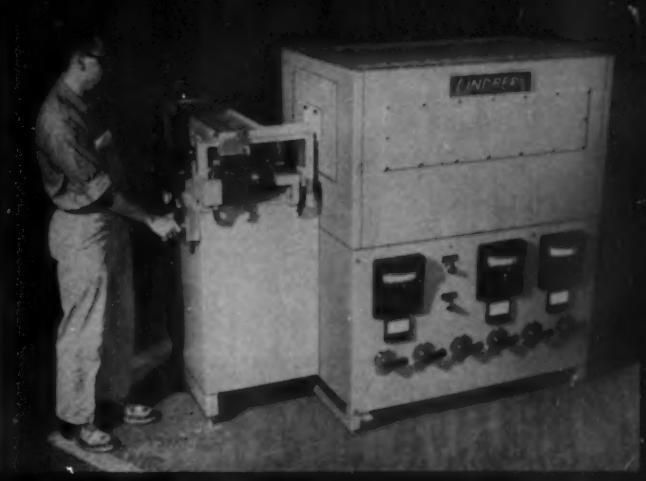

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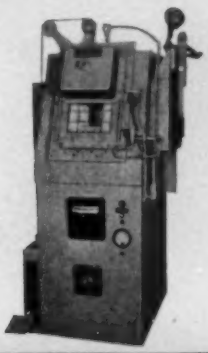

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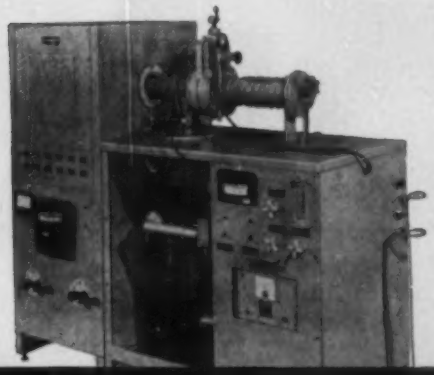

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Look at its general physical and chemical properties here and you'll discover – we hope to your surprise – why NEWPORT Pine Oils are also used as: *Mining Frothing Agents, Textile Wetting Agents, Pigment Grinding Aids, Gelatin Retarders* and *Flow Viscosity Improvers.*

Its uses are not limited to one field, but include soaps and cleaners, paints and varnishes, cutting oils, metal chrome polishes, essential oils, ore flotation, pharmaceuticals and leather processing.

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GENERAL PHYSICAL AND CHEMICAL DATA OF TYPICAL NEWPORT PINE OIL

	Weight Per Gallon @ 15.5° C. (lbs.)	Specific Gravity @ 15.5° C./15.5° C.	Refractive Index @ 20° C.	Engler Distillation °C. 5%	50%	95%	Flash Point °F. (open cup)	Kauri Butanol Value*	Polymerization Residue
G.N.S. No. 5	7.76	0.932	1.482	200	212	220	167	Inf.	0.5%

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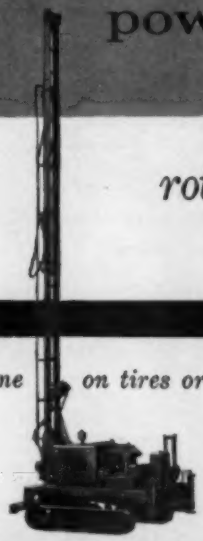

These rigs come on tires or tracks!

Here's a highly portable blasthole drill for drilling holes up to 4½ inches as deep as 30 feet... equipped for either positive-drive rotary drilling or powerful down-the-hole percussive drilling.

What's more, the LRD-2 is completely self-contained... and economically priced, too!

The entire unit is easily handled by one man. Controls are conveniently grouped at an operator's station located alongside the drilling area. The unit can be moved, leveling jacks hydraulically set, mast hydraulically raised, drill pipe and bits connected, and hole started all with a few nonfatiguing motions.

Powerful direct mechanical drive keeps the rotary table turning — won't bog down or lose torque under rough going like air or hydraulic driven units — eats through tough rock formations under 10,000 lbs. pulldown pressure at speeds from 40 to 250 rpm. If necessary, a hard-hitting down-the-hole drill can quickly be substituted for the rotary bit to drill extremely hard rock formations.

A Le Roi 25 hp two-stage air compressor provides ample air for powering the down-the-hole drill and cleaning out hole . . . or is available in single-stage where only rotary drilling is necessary.

The self-propelled LRD-2 is available either on crawler or tire mounting and with either gasoline or diesel power unit. A whole list of extra equipment is available to ease or speed drilling, including lights for night-time operation, a mounted bit grinder, air hoist, breakout tongs, water injection system, . . . all detailed in Specification Sheet AT-146. Write for your copy.

AT-018

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TRANSACTIONS Vol. 217 (Society of Mining Engineers)

This new and expanded volume of Mining Transactions AIME contains over 350 pages of material never before published as well as articles which appeared in MINING ENGINEERING during 1960. Use the handy blank at the bottom of this page to order your copy of Volume 217 if you have not already done so. A partial contents list follows.

Price: $7.50, soft covers (AIME Members only) **$8.50, hard covers (AIME Members)**
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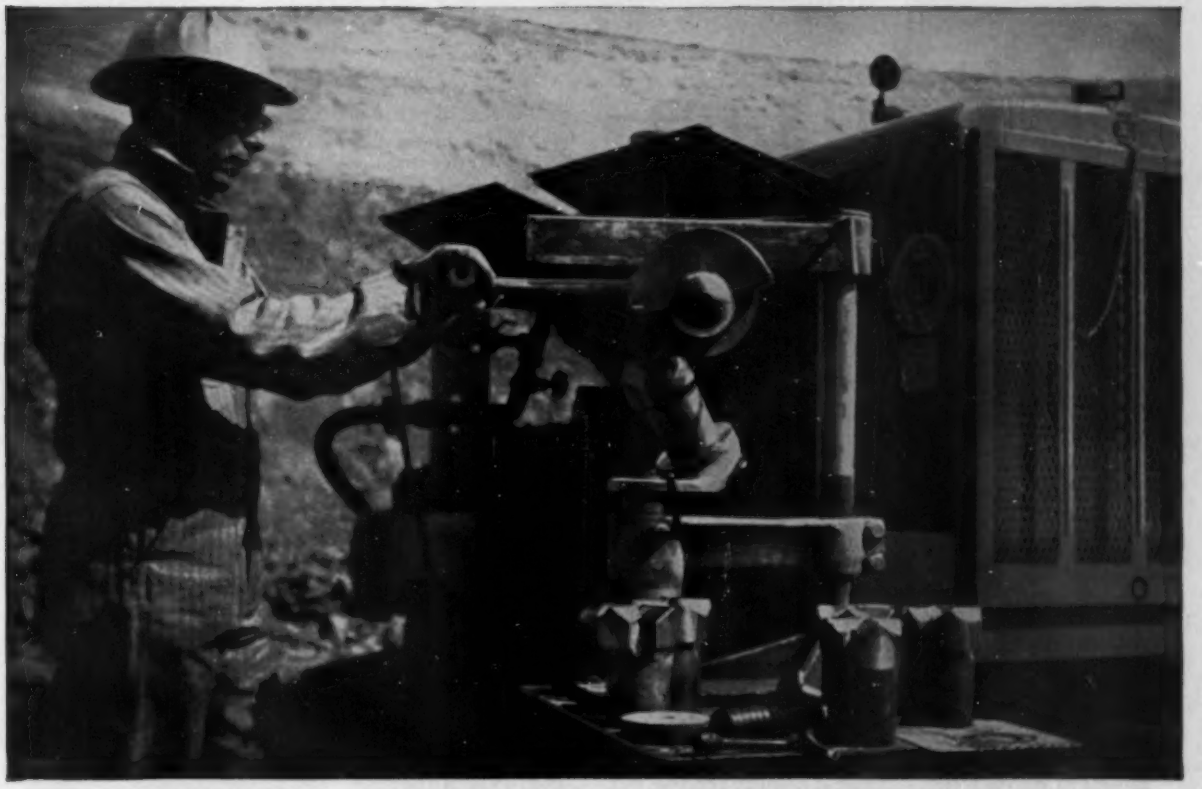

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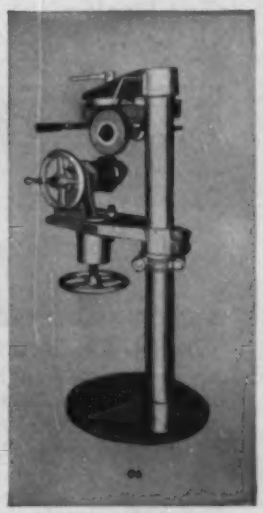

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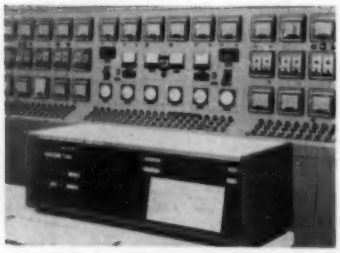
FUTURE TOOLS FOR MINE MANAGEMENT

tool, the instrument by which something is effected or accomplished
Webster's New International Dictionary

A quarter of a century ago a laborer's only tool might be as simple as a shovel. Today, the shovel is still a tool, but the laborer may have traded it for a seat at the console of a machine costing thousands of times as much. The old maxim that "the laborer is worthy of his hire" was never truer. With the tool costs of today and in an era of labor organization one can well update another old maxim to read: "you can judge a management by its tools"—what it selects for the job.

Mining already ranks near the top of all industry in terms of capital investment per employee. For example, Reserve Mining Co. recently quoted the figure of $83,000 per man, and today is investing still more. But, no matter how expensive, how new, or how good our present tools, the mining industry is faced with costs and competition that urgently demand better ones. Where will these machine, processes and methods come from?

For Itself



Today, management *itself* needs new tools to effectively direct operations of ever growing size and complexity. Not slow to recognize this, some mining companies have taken a long hard look at their internal organization, others have turned to studies by management consulting firms. Many organizations have improved executive and supervisory efficiency through training programs, management courses within the company, or by encouraging men to take graduate work in administration.

But, no matter how well trained, organized and led, decisions by management will be no better than the information on which they are based. In the decade ahead data processing and machine computation are two of the means that will prove increasingly important in bettering information for decision making.

Data processing is already in fairly wide use. Ready means existed in many cases through application of existing punched card accounting or other business machines—outside services are another avenue used where work loads do not justify installation or rental of major equipment. Less widely used, computers have seen sporadic application to problems of ore reserve study and analysis of mining plans. Still largely in the future is control of continuous operations—automation, if you like an overworked word.

Mechanized data organization will mean integration of scattered and fragmented facts, and done fast and economically. If neither time nor cost are a bar to the preparation and analysis, many alternative solutions and more accurate decisions will result. Machines will not produce facts, they will not make decisions, but they can be applied to organize the facts into information which will guide wise decision making.

For a report on what has been done this far in applying computers to mining industry problems turn to pages 177 and 179.

New from old

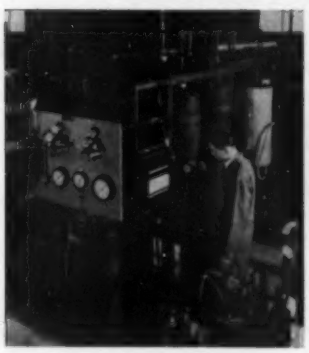
Not all future tools are going to be futuristic —the workhorses will be bigger, faster, and more costly extensions of what we now know how to build. Machine evolution is, however, a slow process. Almost always it takes more time, more skill to evolve from one model to the next, far more perhaps than the first simple design took altogether. In spite of this, there were encouraging signs that the tempo of product development is speeding up:

- One could note major changes in machine size and power; in drilling, in loading, in haulage. These bigger new products evidenced willingness on the manufacturer's part to invest in the future of the industry, and credit on mining for being willing to spend to save and grow.

- There was initiative on the part of users to design and request what they needed, whether or not it was yet on the market. Only a few large firms can afford this type of action, but the resulting developments are important to all segments of the business.

- The coal industry appears to have taken the lead, both above and below ground, in devising combination machines to perform two or more usually separate operations. The continuous miner is a classic example. The monstrous strip mining machines that dig, load, and haul (when coupled with conveyors), are another landmark in the history of integrated mining.

From research



Some of the tools we need will be new ones developed from the old via the painful but dependable process of evolution. Building machines bigger, making them rotate faster, putting superior materials into them are all ways to get better mining equipment. In combination these tested approaches can produce startling results, but the industry can not be content with this type of progress alone.

Breakthrough has become a fashionable term. Actually there are few, but they are needed. And today, research, rather than chance, seems the best source of these vital steps forward. True results from mining research, few though they have been, are a considerable return for the interest and expenditure so far devoted to such research. The application of money, manpower, and a little enthusiasm from "the powers that be" will work miracles in the research programs of the mineral industry.

From the Space Age

The man in the artist's sketch at left is wearing a suit designed to provide environmental control. It provides air conditioning and safe breathing regardless of high or low temperature over wide ranges. In essence, you live inside it. Designed to cope with problems created in missile and space-vehicle launchings, its development was paid for by those programs. It can be used in any one of several nonmilitary industries.

The suit itself is not important, but the idea it represents is important—that there will be a steady series of developments from the space age which, if mining is alert, can be adapted to the industry's benefit.

There is a second point which is not so obvious. During the present period of increasing scientific effort, the mining industry must make its voice heard in order that at least a portion of the vast funds spent for research will also increase our knowledge of minerals, their occurrence, and how to extract them. Let us see to it that Government research programs, now overwhelmingly concerned with the space above us and the ocean beside us, are also directed toward more knowledge of the solid earth beneath us.

ANNUAL REVIEW

U.S. MINERAL PRODUCTION — 1960

Total U.S. mineral production reached an estimated $17.8 billion for 1960, 4 pct above 1959 and second only to the record high of $18.1 billion established in 1957. As a group, metals achieved a rise from $1.6 billion in 1959 to $2.0 billion this year, an increase of 28 pct. Similarly the value of nonmetallic production including fuels (i.e., natural gas, petroleum, natural-gas liquids, asphalt and related bitumens, carbon dioxide, anthracite, bituminous and lignite coal, peat, and helium) rose from $15.5 billion in 1959 to approximately $15.8 billion in 1960. However, this 2 pct increase in the total value of nonmetallic production was due to an increase in the value of the fuels ($11.8 billion in 1959 to $12.2 billion in 1960) which offset a drop in value of the other nonmetallic minerals ($3.7 billion in 1959 to $3.6 billion in 1960).

Those metals whose output was affected by strikes in the last half of 1959 and the first quarter of 1960 —copper, iron, vanadium, and tungsten—all reported increases ranging from 30 to 40 pct for 1960, thus counterbalancing declines in lead, zinc, silver, manganese, rare earths, and thorium. Uranium output increased from $141 million to $156 million in 1960 and small increases were registered by gold and platinum.

Attainment by fuels were mixed, with value increases reported for natural gas, natural-gas liquids, helium, peat, and petroleum. Values of anthracite and bituminous coal output were smaller.

A slackening demand for materials of construction —cement, clays, gypsum, and stone—mainly in residential building, was only partly offset by increased demand for chemical and fertilizer materials. The result was a 2 pct drop in total worth of nonmetals other than fuels. Interest continued in the semiconductor materials— silicon, germanium, and tellurium—although production and consumption of selenium dropped sharply.

COAL PRODUCTION

Bituminous coal and **lignite** output in 1960, estimated at 415 million tons, was up 0.7 pct from the 412 million tons produced in 1959. Production in 1960 was retarded by business declines and the competition of other energy sources. The general outlook at the end of the year was for a stable coal market in 1961.

According to estimates of the Bureau of Mines, production of Pennsylvania **anthracite** in 1960 was approximately 18.1 million net tons, down 13 pct. Contributing to the decline in production was decreased demand in most major markets—domestic and foreign. Shipments to Canada were off approximately 15 pct and, to overseas destinations, about 21 pct. In the United States, total apparent consumption fell 9 pct because of further losses to competitive fuels in the space-heating field and decreased requirements of some industrial users.

INDUSTRIAL MINERALS

The tonnage of both natural and artificial **abrasives** used by industry in the United States during 1960 showed slight declines from the preceding year. However, their total dollar value changed little.

Barite output dropped an estimated 19 pct in 1960, reflecting decreased activity in oil-well drilling. Sales of **boron** minerals and compounds in 1960 dropped slightly in quantity although their value increased. Sales of **bromine** and bromine compounds during 1960 decreased 10 pct, but production capacity increased in 1960.

Production and shipments of **portland cement** decreased 9 pct in 1960 to 305 million barrels. Inclement weather during the winter and heavy rains in the summer slowed construction and production, and shipments dropped to about the 1957 level. Five new cement plants were opened during 1960, one each in Michigan, Ohio, Oklahoma, Texas, and Hawaii. Substantial increases in production capacity at other plants in addition to the new plants raised the annual capacity to 430 million barrels at the end of 1960. Cement imports were estimated at about four million barrels during 1960.

Feldspar production dropped a little below the 1959 tonnage. Imports of **nepheline syenite,** the principal substitute for feldspar, continued at the same high level. **Aplite** output decreased 5 pct.

Domestic fluorspar increased to about 241,000 tons, a 30 pct gain, whereas imports declined about 6 pct. Industrial requirements of fluorspar in the aluminum industry were almost unchanged, but they rose significantly in the steel and chemical industries in 1960. Government acquisition of fluorspar continued under the Agricultural Barter Program.

Output of **gypsum,** which is reflected in the building and construction industries, decreased about 10 pct. Gypsum imports in 1960 were expected to be about 12 pct lower.

The drop in sales of **mica** to the Government under the domestic purchase program was largely

responsible for a substantial decrease in domestic sheet mica output. Production of both **phosphate** rock and **potash** increased 10 pct, due to continued high demand for fertilizers. **Salt** manufacture continued to expand in 1960, establishing new marks. A new mine in Ohio and brine wells in North Dakota contributed to the increase.

Production of **sodium carbonate** and **sodium sulfate** from natural sources advanced 10 and 6 pct, respectively, surpassing the previous records in 1959. A new plant to produce soda ash from Wyoming trona was started.

The output of **Frasch sulfur** during 1960 was at the same level as 1959, but prices were lower. **Talc, soapstone,** and **pyrophyllite**—minerals that find their greatest use in ceramics, paints, insecticides, rubber, and roofing—increased approximately 3 pct, both in quantity and value.

World production of **asbestos** was estimated as slightly higher in 1960 due to small increases in Canadian and Russian output. United States production was up about 2 pct, but imports decreased to 690,000 tons.

METALLIC MINERAL PRODUCTION

Copper production at domestic mines rose about 30 pct over 1959. Work stoppages were still in effect at several properties at the beginning of the year because of strikes which began in August 1959. By the end of February all mines had resumed operations, and in late March settlement was reached at the last strike-bound smelter and refinery.

Smelter production from domestic materials gained 13 pct and refinery output from similar sources increased 10 pct. Refined copper produced from secondary materials by primary and secondary plants rose 11 pct, and exports of refined copper more than doubled.

Decreased demand by consumers in the last half of 1960 caused a 9 pct drop in use of refined copper. Producers' stocks of refined copper at the beginning of the year were the lowest in more than 50 years, but an upward trend began in April and stocks became the largest since the end of 1957.

An unfavorable market, attributed to large surpluses, was responsible for declines in **lead** and **zinc** consumption. Due to the low demand and strikes which curtailed mine output of lead and zinc, the 1960 mine production of 239,000 tons of lead was the lowest since 1900. The 427,000 tons of recoverable zinc produced reflected only a small increase over 1959. Lead exports were small—about 2000 tons—but exports of slab zinc increased six-fold.

Domestic iron mines produced about 86 million long tons of **iron ore** in 1960, 26 million tons more than in 1959 but slightly less than the average for the past five years. Preliminary figures indicate that imports were about the same as the record of 1959 but were less than one-third the total new supply of iron ore in the United States. Exports totaled about five million tons in 1960.

United States consumers used about 100 million of the total 121 million tons of new iron ore and stocked the remainder. Therefore, the total inventory of iron ore at the end of the year was more than 20 million tons above normal.

Domestic production of **bauxite** in 1960 was approximately two million long dry tons, a record peacetime output and 20 pct above the 1959 production. Imports of bauxite were estimated at 8.5 million tons, a 5 pct increase. Jamaica supplied nearly 50 pct of the imports; Surinam, more than 35 pct; and the Dominican Republic, Haiti, and British Guiana, most of the remainder.

A Canadian and two French companies announced plans to construct pilot plants to produce approximately 5000 tons of aluminum per year. Other than stating that the Bayer process for making alumina would be bypassed, there were no announcements of the process to be used.

United States patents were granted The Anaconda Co. on the production of alumina from iron-containing aluminous materials, such as bauxite or clay, through an acid leach caustic purification process. An aluminum sulfate plant, with an annual capacity of 40,000 tons, was being constructed by the North American Coal Corp. Mine waste from the company's coal operation in Ohio will be the raw material used. Upon completion of the plant, the commercial possibility of using the sulfate as a source of alumina will be studied.

Primary aluminum production in 1960 in the United States was a record two million tons, 50,000 tons more than the previous record set in 1959. Shipments of primary metal did not keep pace with production, and it appeared that stocks at reduction plants would be at a record high of 200,000 tons by the end of the year. As a result of the lower level of shipments as related to production, the industry operated at an average of 83 pct of capacity.

Production of **primary magnesium** in 1960 was 40,000 tons, an increase of 9000 tons. Three plants,

with total annual capacity of 47,000 tons, were operated throughout the year. Producers' shipments of 52,000 tons were 4000 tons above 1959. Approximately 239,000 tons of magnesium chloride and calcined dolomite were used in 1960 to produce magnesium. Output of five million tons of magnesite and dolomite for basic refractories represented an increase of about 20 pct over 1959.

During 1960, production of **titanium** sponge metal increased to 4500 tons, approximately 15 pct over 1959. Consumption of the metal also increased 15 pct and about equalled production.

Domestic output of ilmenite increased from 635,- tons in 1959 to a near-record 750,000 tons in 1960. Production of rutile, a co-product of ilmenite operations, was estimated at 9000 tons, about the same as in 1959. Imports of ilmenite, including titanium slag, were about 300,000 tons or 19 pct below 1959's imports. Despite a continuing oversupply of rutile, imports were about 23,000 tons, the same as in 1959.

The domestic **antimony** industry in 1960 was characterized by a rise in primary and secondary smelter production and in imports, exports, and stocks. Mine production and consumption of primary metal dropped slightly, from 678 short tons in 1959 to 650 tons in 1960. No Government purchases were made for the strategic stockpile; barter contracts, however, were executed by the Commodity Credit Corporation to obtain antimony for the supplemental stockpile.

Domestic mine production of **mercury** in 1960 was little changed from 1959. Increased output in Alaska, California, and Nevada more than offset decreases in Idaho and Oregon, and national output totaled 31,500 flasks. Industrial consumption of mercury probably dropped below 50,000 flasks for the first time since 1954. General imports continued the downward trend that had begun in 1957.

Tungsten shipments from domestic mines increased approximately 30 pct in 1960. Tungsten mine production was reported in five States—California, Colorado, Montana, North Carolina, and Nevada. Consumption of tungsten concentrate exceeded ten million pounds of contained tungsten and was the greatest in the last eight years.

The United States depends almost entirely on imports for its **cobalt** with about 80 pct originating in the Republic of the Congo, but troubled conditions in that country during 1960 did not materially affect output. Imports by the United States from the Congo were about 25 pct less for the first nine months of 1960 than for the same period of 1959, due mainly to reduction of deliveries under a Defense Production Act contract now terminated. For the first nine months of 1960, total imports of cobalt were 9.9 million pounds and consumption was 6.8 million pounds. The seizure by the Cuban Government of the almost completed Freeport Nickel Co. nickel-cobalt plant at Moa Bay, with a prospective capacity of 4.4 million pounds of cobalt a year, worsened the general United States cobalt outlook. Defense Production Act inventory, combined with consumers' and refiners' or processors' stocks, totaled 27 million pounds as of September 30, 1960, or about three times the average annual consumption rate for the past five years.

Production of **vanadium pentoxide** in 1960 increased about 35 pct. Domestic production of **manganese** ore containing 35 pct or more manganese was again substantially lower than that of the preceding year. Domestic output of **molybdenum** reached a new peak. Production was from the Climax Molybdenum Mine in Colorado, copper operations in Arizona, New Mexico, Nevada, and Utah, and a tungsten operation in California. All domestic production of **chromite** was from American Chrome Co.'s Mouat mine in Montana and was about the same as in 1959. However, this comprised only about 8 pct of the total United States supply in 1960, the bulk being imported.

Following a four-year decline to the lowest peacetime level since 1892, mine production of **gold** in the United States rose slightly in 1960. **Silver** output, however, declined for the fourth successive year and reached the lowest peacetime level since 1933. Although strikes at major copper mines, which reduced output of byproduct gold and silver last year, were settled early in 1960, strikes at major silver-producing mines in Idaho, begun in May, were the principal factor in the 1960 drop in silver production. The 1960 output of gold was estimated at $58 million compared with $56.1 million in 1959. Output of silver was estimated at $27 million, about four pct less than the 1959 total of $28.2 million. Output of the **platinum-group** metals, recovered from domestic placers and from byproduct sources, increased moderately in 1960, thus reversing a nine-year trend of declines.

Uranium ore production in the United States was about 7.9 million tons, valued at $156 million, compared with 6.9 million tons, valued at $141 million in 1959. Domestic concentrate production in 1960 was about 18,000 tons of U_3O_8, compared with 16,390 tons in 1959 and 12,560 tons in 1958. States producing uranium ore, in order of importance, were New Mexico, Wyoming, Colorado, Utah, Arizona, Washington, Texas, South Dakota, Idaho, Montana, Nevada, Alaska, Oregon, and California. The Atomic Energy Commission announced that uranium purchase contracts with 15 of 27 domestic processing mills have been extended through the 1962-1966 period.

In 1960, domestic mine shipments of **rare-earth oxides** were approximately 25 pct of those for 1959, and mine production of **thorium**-bearing minerals was negligible. This was due to limited markets. Mining companies producing rare-earth minerals and thorium continued to consolidate their holdings and do development and exploration in anticipation of larger markets.

Approximately 210 short tons of hand-sorted **beryl** containing about 11 pct beryllium oxide was produced in the United States, most of which was sold for premium prices to the Government through General Services Administration (GSA) on the "Purchase Program for Domestically Produced Beryl." Through November 1960, GSA had bought 2685 short tons of domestically produced beryl under this program which started in 1952. About 9500 tons of beryl, almost all imported, was consumed in the United States in 1960. Most of this quantity was processed into beryllium metal, alloys, and compounds.

Imports of **columbite** and **pyrochlore** were estimated at 2600 tons, a major increase over 1959; about three-fourths of this supply came from Nigeria. Imports of **tantalite** were estimated at 340 tons, virtually unchanged. About 40 pct came from the Congo and 30 pct from Brazil. Columbium production was estimated at 75 to 90 tons and tantalum at 120 tons.

ANNUAL REVIEW

Twelve of the big mining news stories of 1960

Cuba Seizes U.S. Assets

The Moa Bay nickel and cobalt plant, subsidiary of Freeport Nickel Co., and the U. S.-built Nicaro operation were both confiscated by the Castro government.

Kennecott Dedicates Baltimore Refinery

The $30-million electrolytic copper refinery built by Kennecott Copper Corp. was officially dedicated in 1960. Facility has a capacity of 16,500 tons per month.

Foreign Projects Dominate Aluminum News

Primary aluminum capacity was expanded at home while headlines listed projects such as Fria in Guinea, and Kaiser-Consolidated Zinc in Australia and New Zealand.

Bureau of Mines has 50th Anniversary

Created in a time of heavy human toll in the nation's coal mines, the U. S. Bureau of Mines celebrated its golden anniversary July 1.

Quebec Cartier Project Nears Completion

The huge Canadian iron ore project of Quebec Cartier Mining Co. marked railroad completion and expected to begin shipment of 65 pct grade product in 1961.

Nickel Capacity Expanded

International Nickel Co. opened a new $12-million mill in the Sudbury district and produced first nickel matte from the smelter at the Thompson mine in Manitoba.

Announce Taconite Growth

Reserve Mining Co.'s $120-million expansion program will increase total investment to about $310 million by 1963 and up present 6 million ton per year pellet output.

New Iron Ore Facility for West

A mine and mill for 4000 tpd of iron ore pellets is to be completed by 1962 near Lander, Wyo. Builder is Columbia-Geneva Steel Div. of U. S. Steel Corp.

Texas Gulf Sulphur to Build Potash Plant

Plans were announced to a $25-million potash mining and processing operation near Moab, Utah. Million-ton capacity would make Texas Gulf largest potash producer in the country.

Southern Peru Copper Makes First Shipment

The first blister copper from Southern Peru Copper Corp.'s multi-million dollar project reached the U.S. during 1960.

Arizona Continues to Dominate Copper Exploration

A host of exploration projects ranging from Kennecott's scheduled Safford shaft to many still on the surface marked Arizona as the center of western geological activity.

Iron Ore Reflects Steel Output Trend

Reduced steel production, plus high use of scrap and foreign iron ore, raised iron ore inventories and ended Great Lakes shipping early in the fall.

EXPLORATION IN 1960

From the viewpoint of the independent geologist, the general level of exploration activity in 1960 was not appreciably better than in the previous year. With one exception, there was little intense exploration anywhere east of the Rocky Mountains. Overall, there were three centers of interest in the U.S.: the search for copper in Arizona; for lead, zinc, and iron in Missouri; and for beryllium—anywhere.

ARIZONA

Although physicists will disagree, the magnetic quality of Arizona copper was readily apparent in 1960. Virtually all major copper producers had exploration crews in the field, equipped with budgets suited to their immediate goals. No record is available to the total dollars spent and personnel employed in prospecting by major and minor firms, but there is little question that the past year was a "boom" year for exploration in Arizona. The urge among mining companies to increase their domestic reserves during this period of a low copper market has been prompted by the Lumumba-Castro brand of political upheaval which has made it painfully obvious that a mine in our land is worth two in the Bush. As such, the activity in Arizona reflects the race to find copper deposits, regardless of today's copper price and oversupply, before others claim them.

However an equal, if not more important, stimulus to the search for copper has been the growth of geophysics in the Southwest's copper exploration activities. Geophysical prospecting in this region received its greatest stimulus in 1952 when magnetics, electromagnetics, resistivity, gravimetric, and self-potential methods were successfully employed in the discovery of the Pima deposit at Mineral Hill, Arizona. As added experience was attained, the use of geophysics has increased until today 12 mining companies, including six major mining firms, are fielding geophysical exploration crews in Arizona and New Mexico. Of the methods presently employed, the magnetometer is still in greatest use, but the Induced Polarization method is in the limelight due to its ability to ferret out disseminated copper mineralization at greater depths than any other method.

The single "hottest" area in this region covers a 150-sq mile area south of Tucson. Bounded roughly to the north by the Banner-Pima-Mission Project district of Mineral Mill and to the south by the Duval Sulphur & Potash Co.'s Esperanza operation, this area is the scene of intense interest by many companies. Evidence of this lies in the Pima County Courthouse where records show that the total number of claims filed increased from 1295 in 1958 and 1944 in 1959 to approximately 5000 in 1960. The only other major area within the county contributing to this total is Ajo where Phelps Dodge Corp. is reportedly examining new prospects. As an aside, the Pima County Planning & Zoning Commission has already submitted a plan for rezoning a 50-sq mile area around Sahuarita in preparation for this area's becoming a major mining district.

Indirectly stimulating a flurry of staking activity in this south Tucson area, USGS Bulletin 1112-C contains the theory that a near-horizontal post-mineralization thrust fault underlying the Mineral Hill District cut the ore zone and moved the upper portion 6½ miles north to the site of the Pima property. When the bulletin appeared earlier in the year, one company immediately staked the area overlying the theoretical root of the fault.

Elsewhere in Arizona, renewed interest has been exhibited north of Kingman where Duval Sulphur & Potash Co. is conducting extensive core-drilling on a copper prospect at Ithaca Peak, near Chloride. This prospect, previously examined by other companies, is a sheared quartz monzonite stock containing chalcopyrite-pyrite mineralization. Other firms are also present in the area conducting geochemical surveys and basic mapping programs as far south as the Bill Williams River.

Further east near Prescott, Phelps Dodge Corp. is reportedly continuing its exploration work, the only major company so extensively engaged in that area. However, many smaller companies including Verde Exploration Ltd. are similarly employed in this

area extending from north of Prescott, along the base of the Plateau, south to Wickenberg and Phoenix. Verde's immediate interest is in the Jerome district where the company is applying concepts of hydrothermal alteration as a key to uncovering other copper deposits in the area.

Southwest of Morenci, Kennecott Copper Corp. has terminated its present phase of core-drilling and is now sinking a 1½-compartment exploratory shaft on its Safford copper prospect. This shaft, started in November and due to be completed in early March, will be bottomed 800 ft below the surface. A 1500-ft long cross cut and subsequent drifting operations are planned to provide bulk samples of the oxide copper ore. Nearby, Phelps Dodge Corp. completed its initial phase of core drilling in an area just northwest of Kennecott's property. The company recently exercised its options on this land for an estimated $3.5 million.

On the San Carlos Indian Reservation north of Safford, Hunting Geophysical Corp. began an exploration program last spring which included geochemical and geophysical surveys. It is thought that an IP survey encountered a large anomaly but no official information is available. The present work is now under the jurisdiction of the San Carlos Exploration Co., a subsidiary of Hunting Geophysical Corp.

In addition to its San Carlos project, Hunting Geophysical recently announced the successful completion of negotiations for exploration rights on the Papago Indian Reservation, which covers most of the land between Ajo and the Mineral Hill District south of Tucson. To date, the company has not announced when exploration activities will begin.

At the San Manuel mine, located northeast of Tucson, The Anaconda Co. conducted an underground drilling program of its property adjacent to the mine. This work was done from the San Manuel mine's workings.

Northeast of the San Manuel mine, Duval Sulphur & Potash Co. examined another prospect, but the company dropped its option after coring 400 ft and drifting 200 ft.

Bear Creek Mining Co., Kennecott's exploration subsidiary, has shown interest in various prospects in Cochise Co. Among these different areas, the company is reportedly examining the Courtland-Gleeson area east of Tombstone, having filed claims earlier which cover six square miles.

SEARCH FOR BERYLLIUM

The lightness, strength, and heat resistance qualities of beryllium have been known to metallurgists for many years, but the use of this desirable metal has been seriously hampered by the limited, and occasionally uncertain, supply of its ore and concentrates. This limitation was due to the fact that the only commercial source of beryllium was the mineral beryl which occurred as scattered crystals through certain pegmatites. Until recently, the only economical method of sorting and concentrating such beryl was hand cobbing, a process which seldom achieved a recovery rate exceeding 50 pct. This factor, plus the sparse distribution of beryl in pegmatites that often required at least 200 to 250 tons of rock to be removed to obtain 1 ton of beryl, combined to make this metal sell today at about $70 per lb, a cost prohibiting its use in the many industrial applications to which it is suited.

The spurt of interest in beryllium by mining companies and individual prospectors is attributable to recent developments in the concentration of beryllium ores. Experiments in the flotation of beryl have been conducted for several years by the U.S. Bureau of Mines and private firms. In the latter part of 1960, it was announced that Edward Van Dornick had developed a commercial flotation process with a 90 pct rate of recovery. The details of this process have not been released, but it is of particular importance for it is reportedly applicable to such non-pegmatitic, low-beryllium content ores as phenacite, helvite, and bertrandite, as well as to beryl itself.

Another flotation process for beryl began trial runs at the Keystone, S. D., mill of Northeast Defense Materials last July. This 100-tpd mill was designed to produce columbite, tantalite, potash feldspar, and mica in addition to the beryllium concentrate.

Exploration for beryllium in 1960 was highlighted by the intense activity of prospectors in the Topaz Mountain area of western Utah. Reports of the discovery of a major beryllium deposit at this location (150 miles south of Salt Lake City and 45 miles northwest of Delta) generated a claim-staking rush which bore a marked similarity to the post-war uranium rush. About 1000 claims were filed on this area in the past year, with important holdings being obtained by Vitro Minerals Corp. and Beryllium Resources Inc.

Chemical identification of the complex beryllium ore has not been completed, but laboratory analyses reportedly indicate it to be similar in composition to bertrandite ($4BeO \cdot SiO_2 \cdot H_2O$). Vitro, however, believes it has discovered a new beryllium mineral and has named it "vitroite."

The ore is disseminated in a volcanic tuff underlying a bed of rhyolite. Bruce Odlum, president of Beryllium Resources Inc., recently stated that the tuff at this company's property is sufficiently soft to permit ripping and scrapping by tractors. The company has designed a 250-tpd mill to be located near its deposit and completed by the end of 1961. The mill will employ the Van Dornick flotation method to upgrade the 1 pct beryllium oxide ore to a 7 pct beryllium oxide concentrate.

In September, Vitro Minerals Corp. was awarded a $37,720 loan from the Office of Mineral Exploration for further beryllium prospecting. The first company to receive an OME loan for this purpose, Vitro has indicated that it will use this money for conducting additional examinations at Topaz Mountain.

Also reported to be exploring this area, and in some cases filing claims, were E. I. duPont de Nemours Corp., U. S. Steel Corp., Combined Metals Reduction Co., and Food Machinery & Chemical Corp.

In July, a new deposit of beryl was reported at Mt. Baldy (Juab Co.) near the Utah-Nevada border. Located about 60 miles west of the Topaz Mountain district, this deposit contains crystals of beryl which assay 14 pct beryllium oxide and a quartizitic rock with a 0.5 pct beryllium oxide content.

The midyear announcement from the U.S. Bureau of Mines pertaining to an exploration program for beryllium and cesium in Montana, Idaho, and Washington was followed in September by the disclosure of a widespread occurrence of beryl in the remote Glens Peak area of the Sawtooth Mountains, Idaho. The field program in this state is being con-

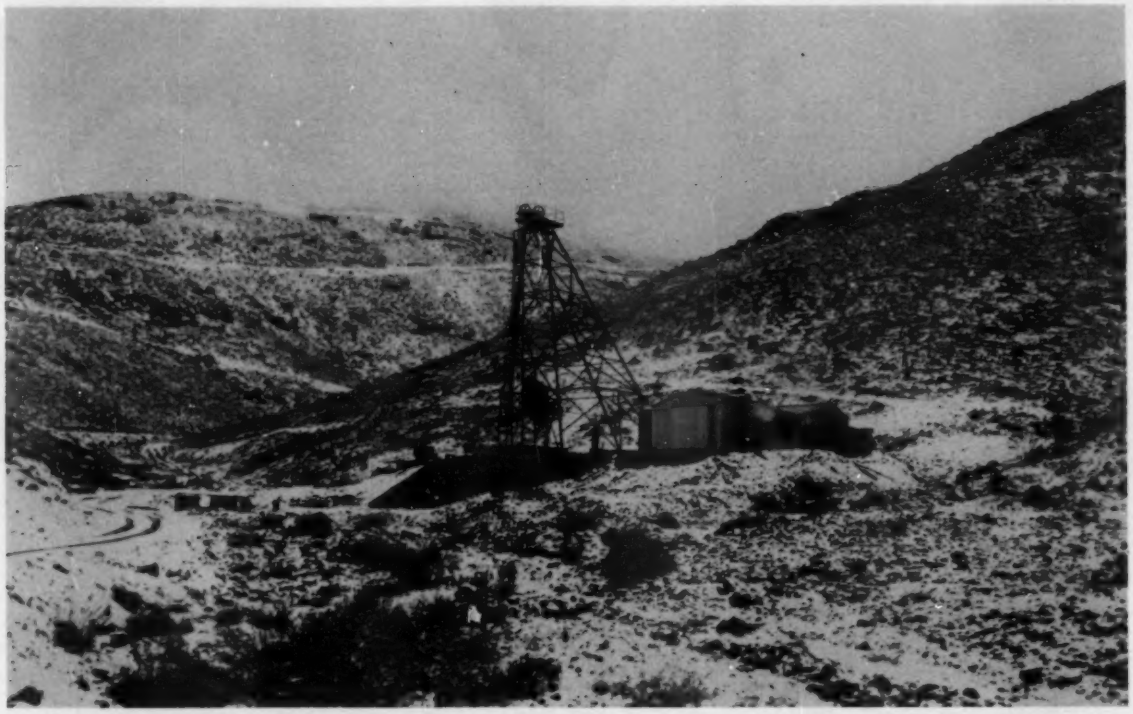
In September 1960, Texas Gulf Sulphur Co. announced the completion of a core-drilling program on an extensive—and possibly the richest—potash deposit in the U.S. Located at Cane Creek, near Moab, Utah, Texas Gulf previously optioned the land from Delhi-Taylor Oil Corp. which had been exploring and testing the deposit. Texas Gulf supplemented its findings with information from logs of eight oil wells located nearby. $25 million will be spent to bring the property into production by late 1962 at an annual rate of 1.5 million tons of muriate potash.

ducted under the joint auspices of the USBM and the Idaho Bureau of Mines and Geology, one of the first agreements of its type. The Spokane, Wash., office of the USBM has been assigned engineering and sampling work; the state agency is responsible for advance reconnaissance and geological studies.

Initially reported to the Idaho Bureau by a prospector, the Glens Peak prospect contains aquamarine beryl disseminated in granite. Although no commercial deposits were found during the limited period of exploration, Beryllium International Inc. has acquired an option on the discovery claims from the prospector and expects to start geologic work soon to determine the extent of mineralization and the commercial possibilities of this strike.

A second discovery of widespread beryllium mineralization in Idaho was reported in November. Previously unknown, this deposit was found through the reconnaissance sampling program of the USBM-Idaho Bureau in the Yellow Jacket Mountains, 80 miles north of the Sawtooth Mountains and 15 miles west of Cobalt. The prospect consists of both green and aquamarine-type beryl disseminated in a granitic country rock. As was true with the earlier discovery to the south, limited exploration has not uncovered any commercial orebodies.

Indicative of the growing interest in beryllium was the announcement in December that The Anaconda Co. successfully concluded negotiations with Mt. Wheeler Mines Inc. for the optioning of 103 claims in the Mt. Washington area of Nevada. The first major mining company to acquire a beryllium deposit, The Anaconda Co.'s holdings in this district now totals 2300 acres. Immediate development



Headframe of the exploration shaft now being sunk on Kennecott Copper Corp.'s property near Safford, Ariz.

to block out the underground reserves of disseminated phenacite and bertrandite is scheduled.

Earlier this year, Beryllium Resources Inc. terminated its option-purchase agreement with Mt. Wheeler Mines Inc. at this site when the amount and grade of ore encountered by Beryllium Resources was not felt sufficient to warrant the continuation of its program.

Other developments within the beryllium mining industry included U. S. Beryllium Corp.'s acquisition of the Red Skin mine, located northeast of the firm's Boomer mine at Badger Flats, Colo., in an effort to increase their ore reserves. Production from the Boomer mine totalled 1200 tons in 1960, approximately four times that of any previous year. In California, the White Caps Gold Mining Co. entered the beryllium business this Fall by purchasing a beryl and phenacite property east of Lone Pine. White Caps simultaneously announced that immediate development work is scheduled.

The future of beryllium and the development of ore reserves are, of course, dependent on the growth of the market for this metal. The bottleneck at the concentrating stage has been broken, and the progress shown to date by members of the industry prompted one authority to recently state his belief that the U.S. will become self-sufficient in this strategic material within a few years.

MISSOURI

The exception to the doldrum of exploration work prevailing in the eastern portion of the country was Missouri. The lead, zinc and iron deposits of this state continued their appeal to many of the major mining companies, including St. Joseph Lead Co., Bear Creek Mining Co., New Jersey Zinc Co., Eagle-Picher, Asarco, and National Lead Co., and American Zinc, Lead and Smelting Co. Reports indicate that the areas holding the interests of the above firms are generally confined to the southern portion of Missouri.

American Zinc, Lead and Smelting Co., in conjunction with Granite Steel City Co., continued their exploration program for iron ore resources. Their interest has been centered around two areas, the Boss-Bixby district of Iron and Dent counties were commercial thicknesses of both copper and iron have been encountered, and near Bourbon (Crawford Co.) where they have been highly successful in encountering a sizable magnetite deposit. The ore zone is reportedly 700 to 1700 ft thick and located at a depth of 1700 to 3500 ft below the surface. Testing has indicated the ore to be amenable to upgrading to 65 pct Fe.

Iron has also held the interest of The Taylor Oil and Minerals Corp. which is examining approximately three square miles in Douglas Co. along the southern border of Missouri.

Eagle-Picher Co. is reported to have leased property in the Granby area below Joplin, but the Bunker-Viburnum area of lead mineralization in the eastern portion of the state is presently attracting most attention from the other mining companies. The purchasing of land and acquiring of mineral leases maintained a spasmodic but often brisk pace in Shannon, Reynolds, and Iron counties during 1960. In the vicinity of Bunker, St. Joseph Lead Co., Asarco, and American Metal Climax have been active in the acquisition of exploration rights. Five miles southwest of these properties, Bear Creek Mining Co. has been conducting an extensive core drilling program during the last 18 months. No report on their properties is available, but it is thought that extensive lead mineralization has been found.

National Lead Co. is active in Perry and St. Francois counties of eastern Missouri. The firm has reportedly taken up land options and leases.

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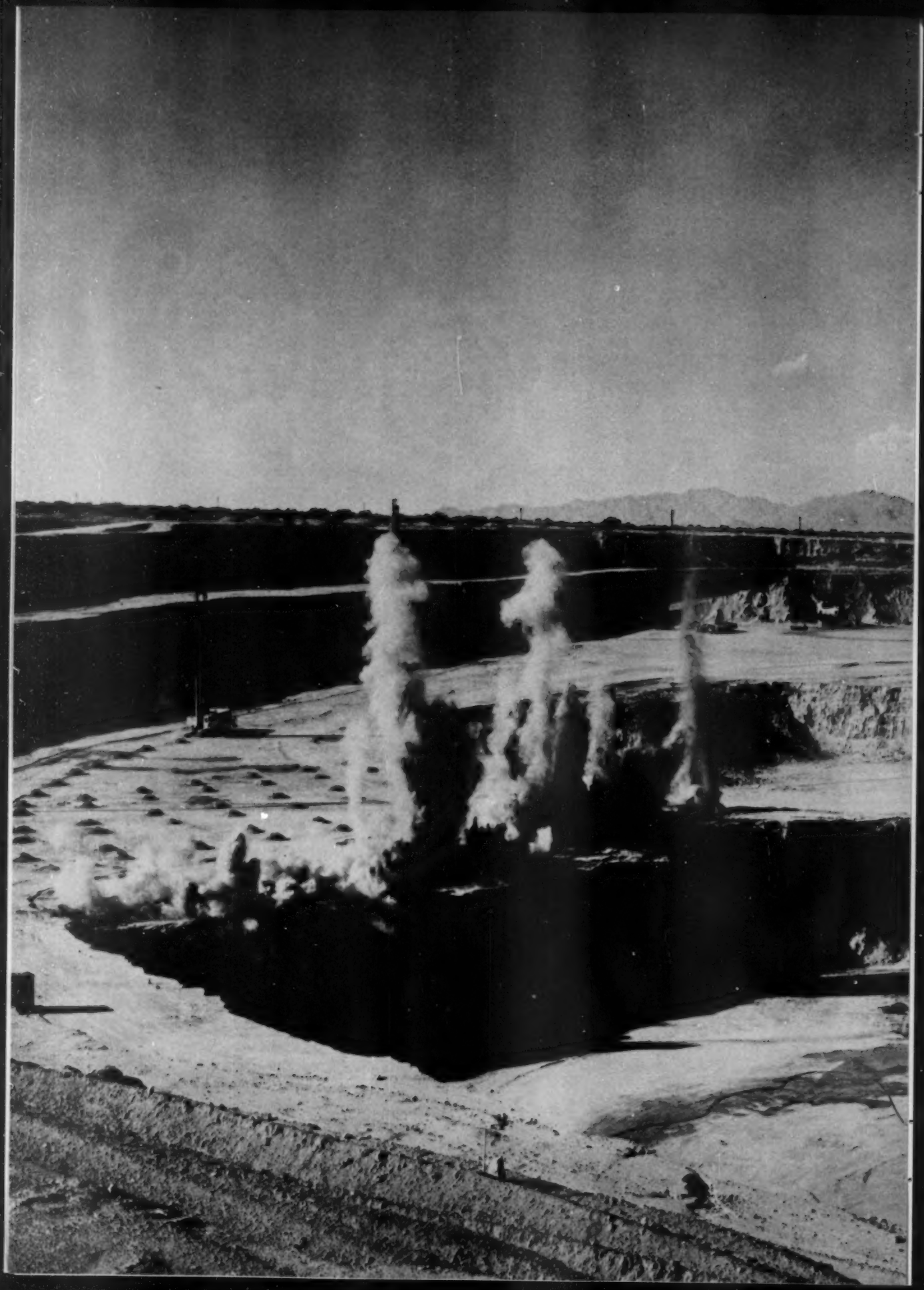
NOTE: Exact titles of curricula vary. Consult latest school catalog for specialized curricula.



ANNUAL REVIEW

MINING DEVELOPMENTS — I

More long-hole and large-hole drilling—for faster raising and better mining rates—are among the significant cost reduction efforts reported in this article which emphasizes drilling trends and activity in the eastern part of the country.

by C. E. MALMGREN

While underground mining operations in the eastern U.S. were curtailed in many areas during 1960, a number of interesting techniques have been developed in an effort to increase productivity and lower costs. The following paragraphs briefly describe some of the more important ones.

At least three separate mining areas in the eastern U.S. have placed mechanized raise climbing machines in service during the past year. These machines take the place of the drilling platform and also embody a complete means of servicing the raise. One operator is contemplating the idea of leaving the service track of the raise climbing machine behind in selected raises, for handling supplies later. The users reflect general satisfaction and feel that the economics of this method are well justified especially in vertical or nearly vertical raises which extend over 100 ft.

LONG-HOLE RAISES

Several mining districts have been trying out the so-called long-hole raising method. This system involves the long-hole drilling of a complete raise round from the top or bottom, with the holes breaking through to another opening. It is especially important to maintain proper alignment of the holes nearest the burn cut hole and in most cases, the cut hole is drilled or reamed considerably larger than the rest to improve chances of good breakage.

In long-hole raising, the first two or three rounds are usually loaded and fired from the bottom of the raise, with the rest of the rounds being loaded from above and fired from a remote control station. The biggest problem encountered thus far has probably been the development of consistently workable techniques for proper firing. If the cut hole plugs, it must be cleaned and if other holes plug, they must be checked to ascertain they are open deep enough to do their share in the next firing sequence. Hole alignment has not been too serious a problem, although one or two extra holes may be needed to insure a satisfactory pattern.

In long-hole raising there is a temptation to make rapid progress, but wise hands caution to go ahead slowly before trying to pull a long round. Despite these problems, the method offers advantages in safety and economy, such that several mines are pursuing their investigation with additional raises.

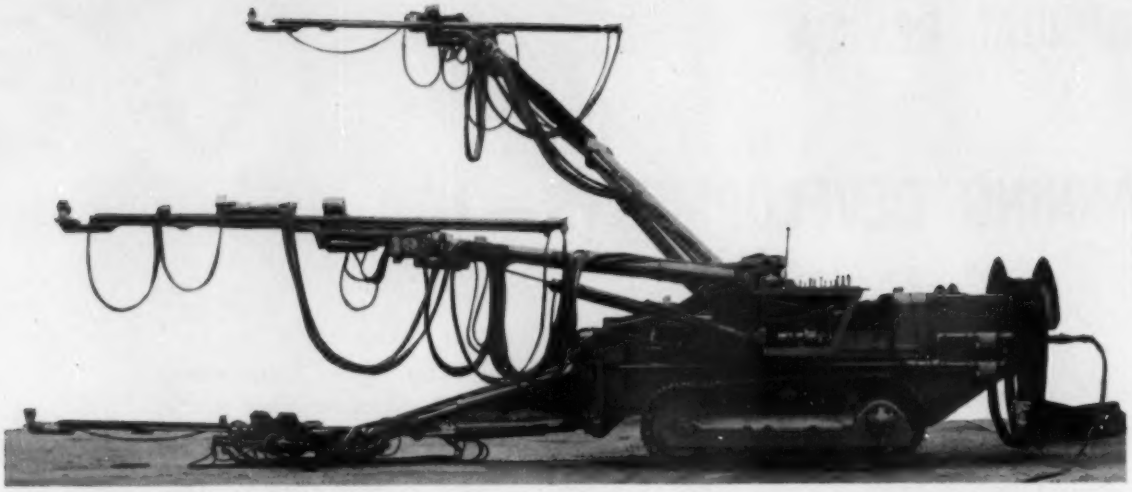
Another underground field where large diameter holes have been receiving attention is for introduction of fill into old workings and such holes are also being used for ventilation in hard-to-reach areas. Normally, a relatively small pilot hole is drilled first, which may be reamed several times to reach the required diameter. In this application, the limitation appear to be length and inclination of hole and, in some cases, the kind of formation to be drilled. At times, it has been very difficult to keep a hole straight enough to come out at the required point. Drills used for this type of work have included conventional, long hole percussion drills; the new independent rotation, percussion long hole drill; down-the-hole tools; and at least one regular rotary drill with tri-cone bits.

UNDERGROUND DRILLING

Several mining companies have adapted larger burn cut holes to their drift rounds. This follows a practice made popular by tunnel contractors during the past four or five years. The mining companies usually put in two or three cut holes which are from 3 to 4 in. diam and may either be drilled in one pass, or drilled and reamed. The cut hole machine is frequently one or two sizes larger than the side machines, but, by changing steels, it also drills part of the relievers around the burn.

In general, it appears that mines adopting this method have added at least 2 ft to the length of round normally pulled, with an especially worthwhile reduction in bootlegged holes.

C. E. MALMGREN, Member AIME, is eastern district manager, Gardner-Denver Co.



Three-drill jumbo features remote control, and requires only two men on crew (one on tractor, one on the ground). Machines like this, plus better burn cut and slabbing rounds, have made large production increases possible.

Base metal mines having relatively flat lenticular ore bodies made strides toward larger use of drilling jumbos with remote controls. The most popular type has been a three drill unit mounted on a crawler-type diesel tractor, operated by two men, one on the tractor and one on the ground. Production rates in excess of 500 tons per shift, including both production and development (heading advance) drilling have frequently been achieved. This shows the progress that has been made—10 years ago, half this figure would have been good. For headings, a burn cut round with larger holes in the burn is usually used. Various slab rounds are used in established stopes.

Underground limestone mines have been adapting two to four-drill remote control jumbos on large truck or tractor chasses. Where heading widths are over 30 ft, some type of "V" cut round is usually utilized, and production rates in excess of 1500 tons per jumbo shift are not uncommon with two men on the drilling crew. Several of these mines are now using ammonium nitrate-fuel oil mixtures for blasting in holes down to 2 in.-diam, with great reduction in explosives cost.

One large limestone mine which uses drawpoint loading has been experimenting with a large apron feeder for loading at the drawpoint, with encouraging results, so far. Rubber-tired front end loaders are receiving greater acceptance underground, especially at properties where distance between blasted faces is sometimes great. Well-trained operators can greatly reduce the tire cost.

There has been more extensive use of percussion long hole drills for exploratory drilling, especially in base metal mines. Economy and faster drilling are principal reasons for the increase. Where minute examination of structure is not essential, a sludge sample, usually covering 3 to 4 ft of hole, gives reliable results.

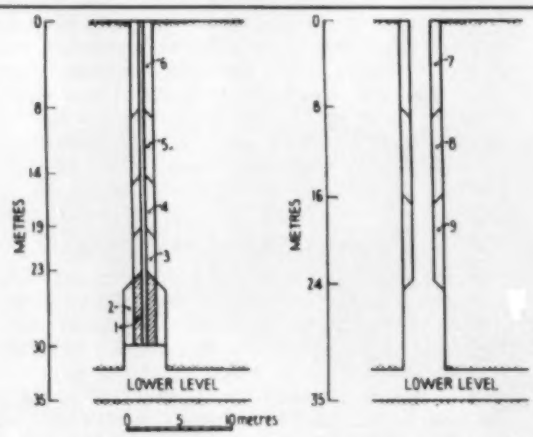


Fig. 1 (left). Scheme for raise blasting eliminating the need for work within the raise

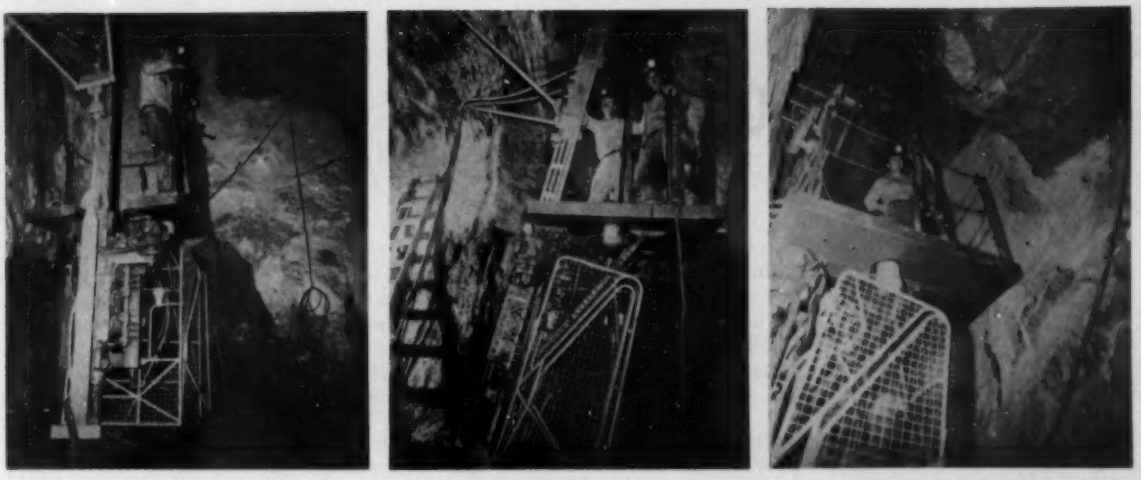
Fig. 2 (right). Enlarging the raise to either full or preliminary dimensions after a central opening has been made

Long Hole Raising

This method of driving a raise, while recent, is not brand new. The reference below, from 1957, is probably the first publication in English of work done in Sweden "whose objective was to eliminate the need for work within the raise."

While the objective was not completely met, the improvement, particularly in driving longer raises has led to a gradual spread of the technique in the U.S. The figure at left, after Langefors shows a two-stage approach, involving a smaller opening being driven through first, followed by slashing to final size. The small numbers indicate sequence of cuts.

Reference: "New Raising Methods, Parts I, II, III" by U. Langefors; *Mine & Quarry Engineering*, Vol. 23, August, September, and October 1957.



These three photographs from SME Preprint No. 61AU26 show the Alimak Raise Climber in use at Shattuck Denn's Iron King property in Arizona. Another method for safer and easier raise driving is shown at the bottom of page 160.

OPEN PIT DRILLING TRENDS

An interesting fact brought out in a Drilling and Blasting Symposium paper given in October 1960, was that all of the light, complete large-hole (6 in. or more) drilling units sold on the Mesabi thus far in 1960 were equipped to utilize down-the-hole percussion drills—when and if the customer desired to do so. It was further predicted, that drill hole size might well be reduced to the 6 to 7-in. range as higher strength slurry explosives became more widely known.

An out-of-the-hole percussion rock drill, with rotation completely independent of hammer action, received wide acceptance in quarries and open pit mines during the year. Another model offering rotation assistance to the conventional rifle bar was also introduced. Both of these drills claimed improved torque characteristics for drilling and the design facilitated coupling or uncoupling of sectional rods.

Inclined holes for quarry face drilling are receiving greater attention, especially with faces in excess of 20-ft height, or, where back-break is serious. Major advantages claimed have been reduction in sub-drilling depth (leaving better condition for next bench below) and greater safety for equipment operating near the face. At least two major rotary drill manufacturers have announced models to drill an inclined hole and, of course, nearly all percussion or down-the-hole rigs can be adapted to drill in this manner. The present optimum angle seems to be about 80°.

DRILL RODS

Carburized drill rod, already widely accepted for sectional steel long-hole drilling, is finding wider usage on jumbos with long change feeds which drill the hole to full depth with a single pass. Other operators have found this rod economical to use with air feed legs and stoper drills. Sectional rod design has trended toward threads that are easier to uncouple and which have improved thread life characteristics. Related to this type of development is the further elimination of the at-the-mine steel shop.

At Climax this is how the scene looked in January at the Storke Yard where siding was nearly complete on the hoist house and the concrete for the shaft collar was being poured. Shaft No. 5 will go down 600 ft as a service and personnel entry to lower levels.—Moly News Photo.

ANNUAL REVIEW
MINING DEVELOPMENTS — II

With major labor strife reduced during the year, mining operators in the West could concentrate more on operation, less on negotiation. In the Southwest, work went forward on the stripping job at Mission, and other projects were underway at the older properties. In Utah, open pit interest logically centered on the work at Utah Copper. To the north, many visited or saw films of the trolley powered truck on test at Butte.

Size and variety of equipment on display at Las Vegas in the fall was staggering. Both indoors and out one saw that the mining industry suppliers had broken the size barrier. Much of what was shown was already in operation, if not as production models, at least on field test. With the sole exception of certain items in drilling, the trend was to bigger, heavier, and much more powerful equipment. High strength materials were more widely used, but often to stretch capacity, not to shrink unit size.

In a few short years production trucks have doubled in size. Through bigger sizes, or faster action, the shovels to match them are also available. And, the same percentage increases shown here could be applied to job capacity across the board.

DRILL

In the Southwest Inspiration reported on its experience with a 9-in. rotary mounted on a truck base, and other operators noted varying but generally good production records with machines of this size. Inspiration's mobile mount was one solution to the problem created by higher production drills—one uses fewer drills, must move each unit farther, or oftener. Up in Minnesota, jet piercing still held sway on taconite, (22 in use,) while increased drilling of hard formation in the other parts of the Iron Range encouraged use of down-the-hole drills. Underground there was perhaps the sole exception to bigger and more powerful machines, as some operators went to still smaller drills, or at least hole sizes, but accurate drilling was a must if rounds with small-diam holes were to break well.

BLAST

One factor alone—lower material cost— has made AN-fuel oil explosives almost a standard above ground. Some operators still use balanced charges with a varying percentage of higher rated explosives, some formations apparently still call for specialized explosives, but these situations aside, AN revolutionized blasting costs for most open pit mines.

Two more revolutions, if you like, are in the making. One, is the introduction of ammonium nitrate mixes for small hole underground use. The second is a new family of super strength explosives, which, in many cases, have been developed with AN as a base. Among these the one in heaviest present use is the AN/TNT/water slurry used by IOCC.

LOAD

Perhaps the most interesting development in this field is the intensified competition of the few suppliers to the mining industry. The industry will benefit, and it is hoped that the shovel builders won't suffer. The most interesting single machine was probably Marion's 13-yd shovel which some have seen in action, live or on film. It is not that larger shovels haven't or can't be built, but shovels had begun to fall into predictable size ranges until larger trucks began to change the operating patterns. Continuing, is the application of front-end loaders of many designs. Heavier machines have meant increasing mining application. Ripper-carryall operations have also been extended.

HAUL

On delivery, on test, or in design, the mining industry has before it the widest selection of trucks ever available. There is a complete range from diesel-mechanical to straight electric, and even gas turbine models. The capacities, both in tonnage and in horsepower at the wheels, extend further than ever before. Cost reduction will result as these new models permit more exact choice to fit each operating problem. Trucks are not the only choice either. Rail still holds its own in the biggest pits, while skip hoists, conveyors, and scrapers offer three more options where material handled, pit layout, and mine life permit. Selection among methods has become more complex, but lower costs can result.

DRILLING AND BLASTING

These two unit operations can not be considered separately, and the rapidity of development in each of the two fields makes constant revaluation of present combined practices a must for each operator. Constant changes in operating practice are a headache, but the benefit has been real progress in lowering costs for rock breakage.

In roughly one decade the classic open pit drilling tools, the churn drill and the wagon drill, have been largely obsoleted. Down-the-hole and rotary types have successfully met the wide range of rock character encountered in mining, while self-propelled and non-powered but tread-mounted drill rigs, often with two or more machines per unit, make attractive options in contrast to the simpler wagon drill. The reduction in number of drills required for given hole production has been as high as 2:1 or 3:1 at many properties. And, this in turn has required improved drill access roads, better drill scheduling, or increased drill mobility. However, development in this area appears now to be at the stage of rapid evolution, not revolution.

In rotary drilling more attention is being given to getting cuttings out of the hole, or at least away from the bit. Dry drilling works well in some situations, with high enough pressure and volume, for other sizes of drill and drilling circumstances detergents and frothers have shown marked improvement in average drilling rate. Closely related to this is the actual bit design. Some operators in the Southwest have found that a tricone does not have to have three parts to work well. One property goes so far as to remove one roller. Probably the unbalanced action plus the greater clearance for chips is what works, in any event despite recent progress much development work still lies ahead in suiting rotary bits to mining problems.

Drilling Research

Future drilling devices may develop from either rotary-percussion machines with some type of vibrating or oscillating mechanism, or perhaps from the line of attack announced by the Russians who have used high voltage, high frequency, electrical discharge for rock breaking on at least laboratory scale. The latter work does not appear too promising yet, but may serve as a springboard for some inventive approach.

In addition to development by suppliers, basic work on the mechanism of the drilling process is continuing at several universities. A report from Pennsylvania State indicates that they have successfully applied photoelasticity to studies of static loading at the bit cutting edge. A summary of research work of a somewhat different nature is currently appearing in *Mine and Quarry Engineering* under the title "The Basic Variables in Rotary Drilling," by B.G. Fish of the National Coal Board, England. Two quotations from this series of papers follow:

(From the introduction)

"This article is the last of a series of publications covering an experimental investigation of small-hole rotary rock drilling carried out at the Mining Research Establishment of the National Coal Board over the period 1953-1958. The objects of this programme were to understand the principles involved in terms of the interaction of the basic variables; to establish, where possible, the best operating conditions for the rotary drilling process and its limits of application; and to provide a body of reliable data upon which the design of efficient rotary drilling machines and tools could be based...

"In considering the variables involved in these studies it is important to remember that it was a *drilling* process that was under investigation and not simply the process, for example, of shearing rock by means of a wedge-shaped tool. This meant that such factors as tool design, rotation speed and method of flushing the debris had to be considered as part of the general process. If all these operational factors are not taken into account the investigation ceases to be one about drilling and becomes something else."

(And from the conclusion)

"Although the precise mechanism of rotary drilling as a dynamic process remains complex and difficult to define, the interaction of the basic operational variables is now clear. But it must be emphasised that however well the rotary drilling machine has been designed, and however close its application is made to approach the best possible practice, abrasive bit wear still remains the limiting feature. The rate of wear is the final criterion of usefulness, and the range of rocks suitable for rotary drilling cannot be widened without the further development of cutting edge materials. Recent Russian work has considered the use of ceramic tips of sintered alumina which, it is claimed, are better able to retain their hardness at high temperatures because of their refractory properties. They have so far only been employed successfully in coal, and there are serious mechanical problems in their application, but it may well be that developments of this kind will eventually increase the usefulness and economy of rotary drilling."

Inclined Drilling

Dr. Kochanowsky of Pennsylvania State University presented a paper this fall at the 10th Drilling and Blasting Symposium, Golden, Colo., on the "Theory and Practice of Inclined Drilling for Surface Mining." An earlier paper, MINING ENGINEERING, September 1955, by the same author also covered the topic, and as the author himself points out the idea is old. Until recently application of the idea had been limited. To answer some of the questions asked about inclined drilling, as well as to cite the advantages claimed, Dr. Kochanowsky uses a question-and-answer form to deal with: What is the active length of a borehole? Where can inclined drilling be applied? Does inclined drilling require more footage per cubic yard of rock than a vertical hole? Particularly interesting are the side advantages cited by some operators, including reduced back-break, and reduced toe problems despite lessened subdrilling. Machines specifically designed for inclined drilling, such as the Joy 965 BH at right, are now available, and others can be adapted.

New Explosives

Three events roughly coincided: introduction of ammonium nitrate as a mining explosive, publication of physical and mathematical approaches to the explosion reaction, and military research expenditures on explosions of various types. Individually they would have had an effect, collectively they initiated a continuing revolution in blasting theory and practice.

The first product of the revolution, underground use of ammonium nitrate, is past the point of being a novelty. Numerous cautions on its use still exist, but workable procedures have been established and proven for holes as small as 1½ in. and the fume problem has not been serious. In one report, International Minerals & Chemical Corp. indicated an almost 50 pct saving in explosive cost. International Salt Co. in another paper (SME Preprint 61AU25) estimates company-wide savings through AN/FO use underground at a quarter of a million dollars. Boliden is using AN/FO mix in holes down to 28 mm, with two primer sticks of dynamite. The USBM has already issued IC7988, "Tentative Safety Recommendations for Field-Mixed Ammonium Nitrate Blasting Agents," which covers underground useage. Two devices, one U.S., one foreign, are available for pneumatic placing.

A second outgrowth of the introduction of ammonium nitrate has been the invention and patenting of the slurry-type mixtures, of which the best known is an AN/TNT/water mixture already in field use. Other slurries, and other physical forms including gels are now being made available. More than 10 million pounds a year of the initial type slurry is already being used in Canada, and application in Minnesota to the harder formations is growing. One of the high velocity slurries, DBA-3, has also been introduced for underground use.

Old but True

The gist of one technical paper being presented in the near future can be boiled down to these six words: *care of drill rods saves money*. One can demonstrate the truth of this on either practical or theoretical grounds, but it is still hard to put in practice, however worthwhile. The second old but true statement is that: too many holes (1 in. or 9 in.) are stemmed with explosive, too few stemmed with stemming. This also is hard to put into practice, since it seems to go against logic that less explosive plus stemming is better than more explosive, period. Savings per hole are small, ill effects of lack of stemming non-dramatic (unless someone's car gets bombed), so execution sometimes lags intentions.

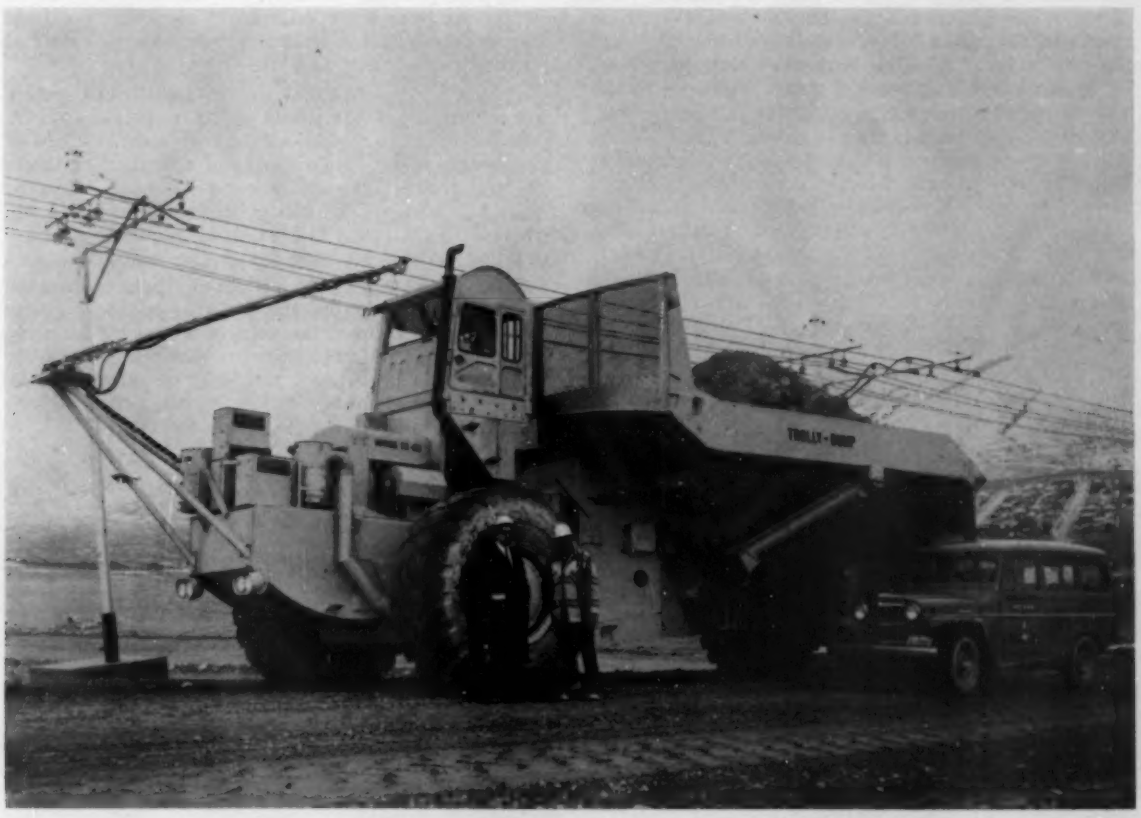
Putting ammonium nitrate in pneumatic placer at Retsof mine, International Salt Co.

Placing ammonium nitrate/fuel oil mix in drill hole through plastic feeder tube.

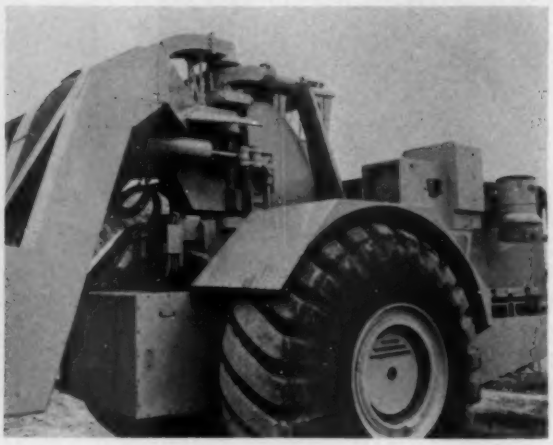
Loading and Haulage

In the comments that follow two facts should not be lost sight of—that the biggest truck in production today is the 95-ton model introduced by KW-Dart, (see inset page 147); that the biggest truck built for mining use is the 150-ton (or 175 ton) monster Western Contracting has in use at Bingham. Both of these are diesel and conventional drive, and while a 95-ton truck is hardly an off-the-shelf item it is available today. It presents no unusual problems of operation, maintenance, power supply or tire life. It is not only of proven design, it is completely versatile.

What other trucks are making news? They are the diesel-electric, and trolley-electric designs which make a complete break with the engine plus power train, in that power is applied in each case through traction motors at the wheel. Three manufacturers are already in the field. Unit Rig & Equipment Co. and Electro Trucks Inc. are utilizing the GE Electric Wheel with a diesel-electric generator for power. R. G. LeTourneau has its own wheel design, placed in a chassis with a small diesel-electric generator and



The R. G. LeTourneau model TR-60 trolley electric truck on test at Butte, Montana.



Two views of the Unit Rig-built Lectra Haul under test by M. A. Hanna Co. on the Mesabi Range.

drawing most of its power from a trolley similar to that made familiar by the trolley bus on city streets.

All three vehicles are on test in the field, and experience should build up rapidly. M. A. Hanna Co. has the 55-ton Lectra Haul of Unit Rig on test on the Mesabi. The other two are at Butte, although not on the same job. F & S Contracting Co. has put a 60-ton Electro truck on its stripping contract at the Berkeley Pit, also site of the test route set up by the Anaconda Co. itself for testing the 70-ton TR-60 built by R. G. LeTourneau.

At least for the present, the purchase price of some of these electric trucks will be above that for conventional trucks of comparable size. What then are the advantages? a) high horsepower at the wheel, b) dynamic braking, and c) design freedom in the absence of a power train. Additionally, proponents point to low maintenance costs, particularly citing the history of railroad and other proven equipment with traction motors. These factors apply almost equally to the trolley-electric and diesel-electric designs. What additional factors apply to the trolley electric? On the plus side, by tapping a trolley, almost unlimited power is available at the wheel. On the minus side is the limitation to an installed trolley line. In terms of maintenance cost the diesel-electric generator must be weighed against the trolley line.

M. D. Lackey of Unit Rig, writing of the contrast of the two types of electric trucks (SME Preprint 61AO73) puts it this way: "Our investigations indicate that for most operations with normal grades and lift, the diesel electric truck is the most economical. For conditions of high grades and lift, particularly where electric power is cheap, the trolley truck can be the most economical method of truck hauling."

Biggest problem in sight for the electric vehicle lies in the tires wrapped around the electric drives. The question marks here are: ultimate tire cost at regular production, and tire life.

It is already clear that its versatility will ensure far wider use of the diesel-electric, it also appears possible that the trolley-electric with capabilities of reasonable speed, large load, and operation on up to 15 pct grades may be a competitor of conveyor and skip systems for pits with fairly long life expectancy. (MINING ENGINEERING plans to publish detailed articles on both designs in coming issues.)

In addition to the two big diesel trucks mentioned in the first paragraph, the pictures on these pages show a gas turbine drive vehicle in use by International Nickel Co. in the Sudbury district, Canada. No reports have yet been received on performance, but the turbine electric could provide a fourth type of power supply for haulage.

Scene at Maybell, Colo., shows front-end loader in action on uranium ore.

From Trucks To . . .

Rail haulage continues to hold its own, in the biggest pits, and where there are long hauls from mine to mill. Electric locomotives are making one of their last stands in these pits, but diesels are also operating under the catenary or trolley line. Phelps Dodge thought highly enough of their bright orange diesel locomotives to feature them in color in their annual report last year and at the Symposium on Surface Mining Practices, D. H. Orr outlined some of the steps taken to mechanize maintenance of the 83 miles of standard gage track at Morenci.

Conveyor haulage from open pit got a lift in the West when U.S. Borax chose to put in a 1300-ft

Truck in use by International Nickel Co. at Sudbury, Ontario, has Allison gas turbine under hood.

belt line. High capital cost is not the only contrary factor—if run-of-mine material is not suited physically, a first consideration becomes crushing at the pit, *ahead* of the conveyor, and that description fits most of the "hard rock" operations.

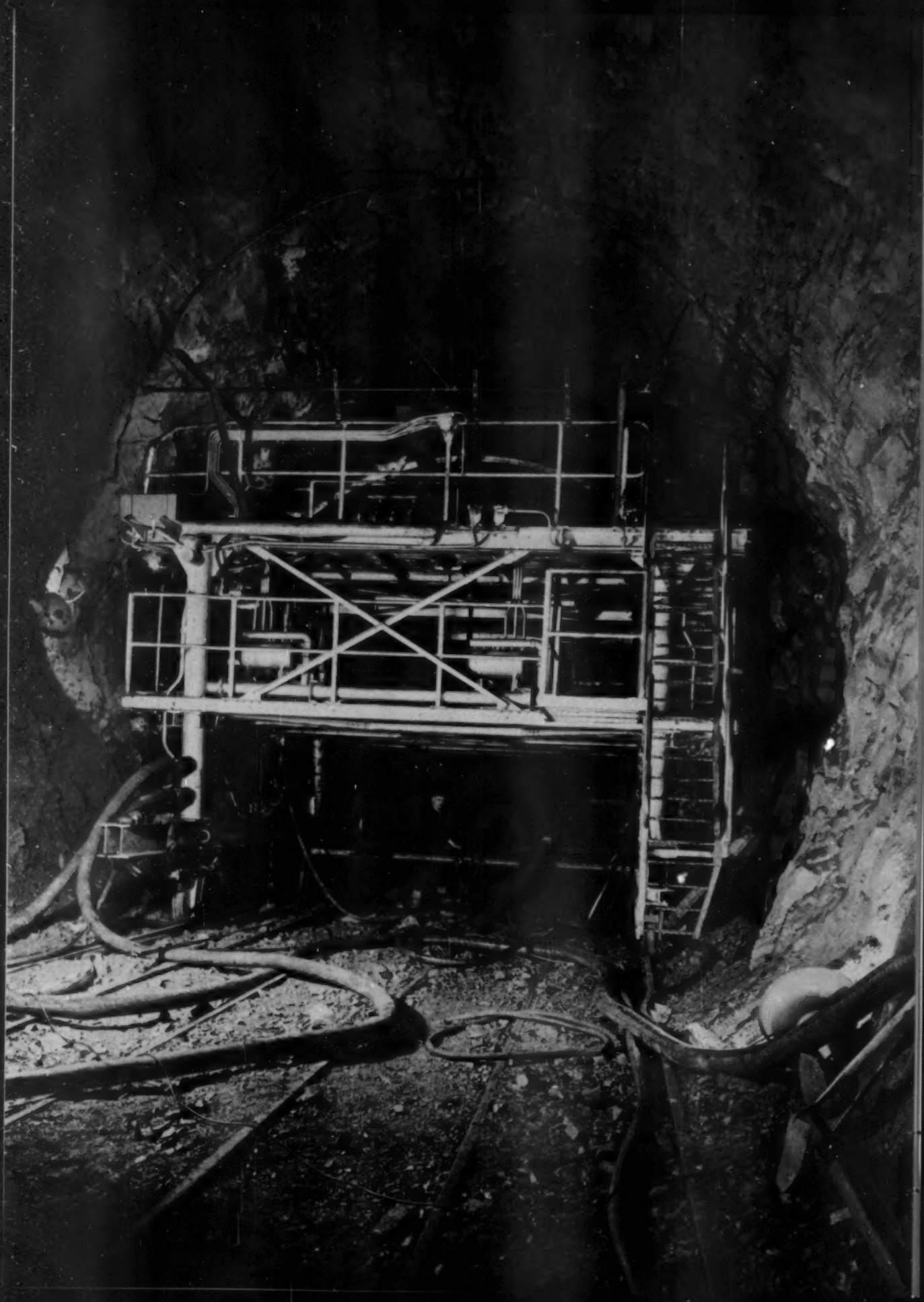
Pima and the Liberty Pit (Kennecott) now have skip haulage up steeply sloping pit sides. Here, as with conveyor or rail, high capital cost is a vital factor, but steeper pit sides may reduce required stripping enough to make the installation worthwhile especially in the light of reduced road and equipment requirements.

For the open pit with a fairly long life ahead of it the choice of original mining plan is becoming increasingly complex, but each added possibility offers hopes of reduced costs for certain types of pits. Making a multiple selection between the various types of trucks available, or against possibly lower operating costs and higher capital costs incurred with skip, conveyor, or rail haulage would appear to call for computer-digested analysis, and this, too, is available. (See "Mining and Computers", page 179.)

Stripping operations have provided some of the more interesting situations during the past year. To recapitulate ones already mentioned: At Butte a 60-ton electric truck is on trial in contract stripping; At Bingham Canyon a 13-yd shovel and a 150-ton truck are among equipment assembled by Western Contracting for a 12 million cu yd stripping job.

In stripping, the ripper-scraper or carryall combination is paying off, particularly with the large tractors now available. Also at Bingham, Morrison-Knudsen is doing the excavating on a 150-ft spiral drop cut to the 5490 tunnel. Unusual feature is that while this job is in ore, little blasting has been needed. At their Mission Project, Asarco had both ripper-carryall and shovel-truck operations underway simultaneously.

Two more views of R. G. LeTourneau TR-60, including a close-up photograph (right) of unique electric motor-driven dump mechanism.



RECENT TRENDS AND DEVELOPMENTS IN EUROPE'S UNDERGROUND MINES

by DAVID SUTTON
Royal School of Mines, London

Despite the many far-reaching advances in science and technology which have been made in recent years, rock breaking still relies upon equipment and techniques that, in principle, are much as they were over half a century ago. Today's knowledge of the physical processes involved in the breakage of rock is far from complete, and we remain committed to the inefficient operation of the discontinuous "drill-blast-clean out" cycle.

As such it was not surprising that some interest was aroused in European mining circles by the revolutionary approach to hard rock excavation as described in a paper by Voropinov and Kittrick, presented at the London Symposium on Shaft Sinking and Tunnelling last year. The authors discussed laboratory experiments of rock breakage achieved by a process known as the *electro-hydraulic effect,* discovered and developed by Soviet scientists. This process utilizes a combination of intense shock waves and cavitation produced by high-energy electrical discharges underwater. The shock waves travel between an electrode and the rock specimen which it is required to break or penetrate. By suddenly discharging a condenser of one microfarad capacity from an initial potential of some 100,000 v, it has been found possible to remove one cubic centimetre of rock, and by means of ionizing relays, repetition frequencies reaching 10^6 to 10^7 per sec were stated to have been attained. This means that breakage at rates exceeding 50 cu yds per min is theoretically possible. No evidence has been given, however, to suggest that any practical application of the electro-hydraulic effect has been made outside the laboratory, and small scale laboratory apparatus cannot be reasonably considered more than a very far cry from a practical mining machine.

DEVELOPMENTS IN MINING EQUIPMENT

No other potential competitors to conventional hard rock mining techniques have come to the fore, but the position of complete supremacy enjoyed for so long by the compressed air-operated percussive machine might appear to some engineers to have lost its seeming impregnability.

In recent years, the Germans and Italians have substituted, on a limited scale, electric power for compressed air in drilling machines. Attempts to develop more powerful electric percussive rock drills continue. To date machines in this class have compared very unfavourably on a power to weight ratio basis with their compressed air-operated counterparts, but they will undoubtedly continue to prove useful in special applications.

Hydraulic percussive machines are again under development after a lapse of many years. In basic design, the early machines in this class were attractively simple, and if it were not for difficulties with pulse generators and transmission pipelines, they should have succeeded long ago. New engineering solutions are therefore essential to their success today, and developments in this field will be watched with interest.

Conventional types of drilling equipment have been substantially improved in recent years. Airleg machines in particular have been brought to an advanced stage of development and now find wide application in production and development work. The design now receiving wide acclaim has a 3-in. bore mounted on an integral airleg retractable under power. This drill, controlled from the backhead of the machine, can deliver 3000 high-energy blows per minute.

In tunneling operations, the recently introduced Swedish ladder drilling method is now being adopted in a number of countries. This comparatively new piece of equipment is essentially a standard lightweight rock drill with retractable airleg mounted in line on a narrow steel ladder. One operator can easily handle at least two machines. Higher drilling rates are stated to result from the greater stability of the machine support; longer steels can be used, requiring fewer steel changes; and both collaring and hole direction are more precise. The method combines the flexibility of the airleg drill with the accuracy of alignment and labor-saving qualities of boom-mounted machines while maintaining cost and complexity at an attractively low level.

On the Swedish Stalon hydro-electric project, at least 16 ladder-mounted airleg machines are used in driving a 10-mile long tunnel. These are operated from a drill carriage by eight men who carry out all operations including blasting, scaling, mucking, and driving the rubber-tired haulage trucks. Performance in this 650 sq ft-section tunnel, including drilling, blasting, and removal, is reported to be 2.1 cu yd per man-hour (rock in place).

Close-up view of the drills on ladder mounts, used in the Swedish ladder drilling method.

Smaller drill carriages incorporating the principles of ladder drilling will undoubtedly prove attractive alternatives to the expensive, complex, and comparatively inflexible boom-mounted drifter equipment in mine development work.

Long blasthole mining has been widely adopted with the development of powerful percussive machines with cylinder bores up to 6 in. diam. Now that the design has been improved, carburizing and correct selection of coupling threads are the topics of most recent concern. Surface patterning of drill steel is considered to be of comparatively small advantage in extending fatigue life, but it does assist in preventing the displacement of rubber collars on airleg steel and adds somewhat to appearance. Less ⅞-in. and more 1-in. steel is now being used by airleg drills.

Deflection problems in deep-hole drilling still limit drilling to a maximum depth of about 100 ft and the percussive drilling of raises and shafts to about 70 ft. In one Swedish mine, trial drilling with 1¼-in. steel to a 170-ft depth resulted in a deflection of about 7 ft. Although low by ordinary standards, this result can scarcely be considered satisfactory.

In anticipation of industrial demand, considerable research effort has been devoted to the suppression of noise from compressed air-operated motors and percussive tools. It has been shown that total noise levels exceeding 85 decibels above the threshold of hearing can cause permanent injury to an unprotected ear. Sound levels in the vicinity of most percussive rock drills exceed this figure, and if more than one machine is used in noise-reflecting surroundings, the risk is magnified. By suitable design of exhaust ports, it has been found possible to effect a 75 pct reduction of the total noise generated by a standard lightweight machine. At this level, "exhaust noise" is equal to "vibration noise", and further reduction necessitates radical treatment.

DEVELOPMENTS IN BLASTING

In the field of blasting, an important development has been the successful use of AN-fuel oil mixes in small-diameter holes underground. At the Boliden Mining Co. operations, experiments using fine-grained ammonium nitrate treated with a surface-activating organic coating indicated a critical diameter for rock-confined charges to be as low as 26 mm. Encouraged by these findings, the Company successfully developed an on-site mixing and loading unit for wet or dry holes at any inclination.

The mixer is a batch-type unit employing a pressure-tight hopper feeding a flexible loading pipe through which the AN-fuel oil is slowly extruded. After blowing out wet holes with compressed air, a plastic bag, corresponding to the blasthole in length and slightly larger in diameter, is placed over the loading pipe. Both pipe and bag are then inserted into the full depth of the hole, and the mixture is introduced through the pipe. Spillage, even when loading vertical up-holes, does not usually exceed 5 to 10 pct. Current experiments are directed towards establishing the most satisfactory means of initiating and propagating detonation of AN in long blastholes, together with an investigation of the fume problem.

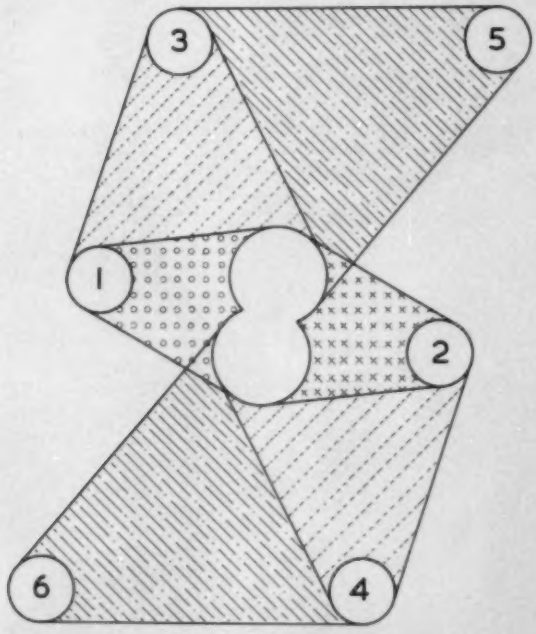
The pneumatic loading of gelatinous explosives into long blastholes has seen long and almost unblemished service in Swedish and Norwegian mines, despite early doubts of its safety. Compared with rod tamping, pneumatic loading in many cases permits 20 to 40 pct more explosive to be placed in a given hole volume, thereby reducing drilling requirements substantially.

DEVELOPMENTS IN DRILLING TECHNIQUES

Hole patterns, particularly the burn-cut rounds, have been under investigation for some time, the main objective being the consistent pulling of long rounds in small drifts with small-diam holes. Sequence firing rather than simultaneous firing is favoured, with hole spacing so chosen that each will break to a clear volume of size adequate to permit ready expulsion of debris.

A cut was developed which has come to be known as the *Coromant cut* (see diagram). It features the provision of relief volume in the shape of a slot formed by two or more overlapping 2¼-in. diam holes. The slot is obtained by fixing a fluted guide tube in the first relief hole drilled and allowing the drill bit to follow along an appropriate groove in the tube when drilling the second hole alongside. Not only does this enable a long cut to be satisfactorily drilled with an airleg machine, but a slot is better from the blasting point of view than a single round hole having the same cross-sectional area. The remaining holes in the cut are laid out in the form of a double spiral, each spiral being independent of the other and providing an opening capable of making the entire round successful. Hole spacings are so arranged that adequate breakage ensues, even if every alternate hole has an abnormally high deviation or if cracks in the rock prevent the desired blasting effect from being obtained in every hole. All holes outside the slot are charged with 0.2 to 0.5 lb of explosive per foot, depending on the ratio of slot width to burden. Firing must conform to a definite sequence as indicated in the diagram; fuse or ½-sec delay electric detonators are recommended. At the Bodas mine of the Sandvik Steel Co. Ltd., advances of 13 ft per round have been obtained in small drifts using the Coromant cut.

The Swedish technique of "smooth-wall" blasting has aroused keen interest in mining circles. This new technique will lead to important reductions in the volume of lining materials required in underground mining and to obvious savings in ventilation costs in unlined shafts and roadways. Clean, undamaged walls result from a proper hole spacing to hole burden ratio for the trimming holes, correct strength and quantity of explosive, near-instantaneous detonation, and a completely free face to which to break.



The drilling pattern of the Coromant cut. The numbers (1 to 6) refer to the firing sequence of the blastholes.

Driller using template to make a Coromant cut. Guide tubes have been inserted in center slot to station the template before the drilling of the surrounding holes.

Laboratory tests and practical experience have shown the ratio of hole spacing to hole burden to be an all-important factor in controlling the smoothness, backbreak, and overbreak of the walls of a finished excavation. For smooth contours requiring minimum support, trimming-hole spacing should be equal to or less than 0.8 of the burden placed on such holes. Where exceptionally close profile control is required, and at sharp radius corners, one or more uncharged holes may be drilled between the charged ones along the intended break line.

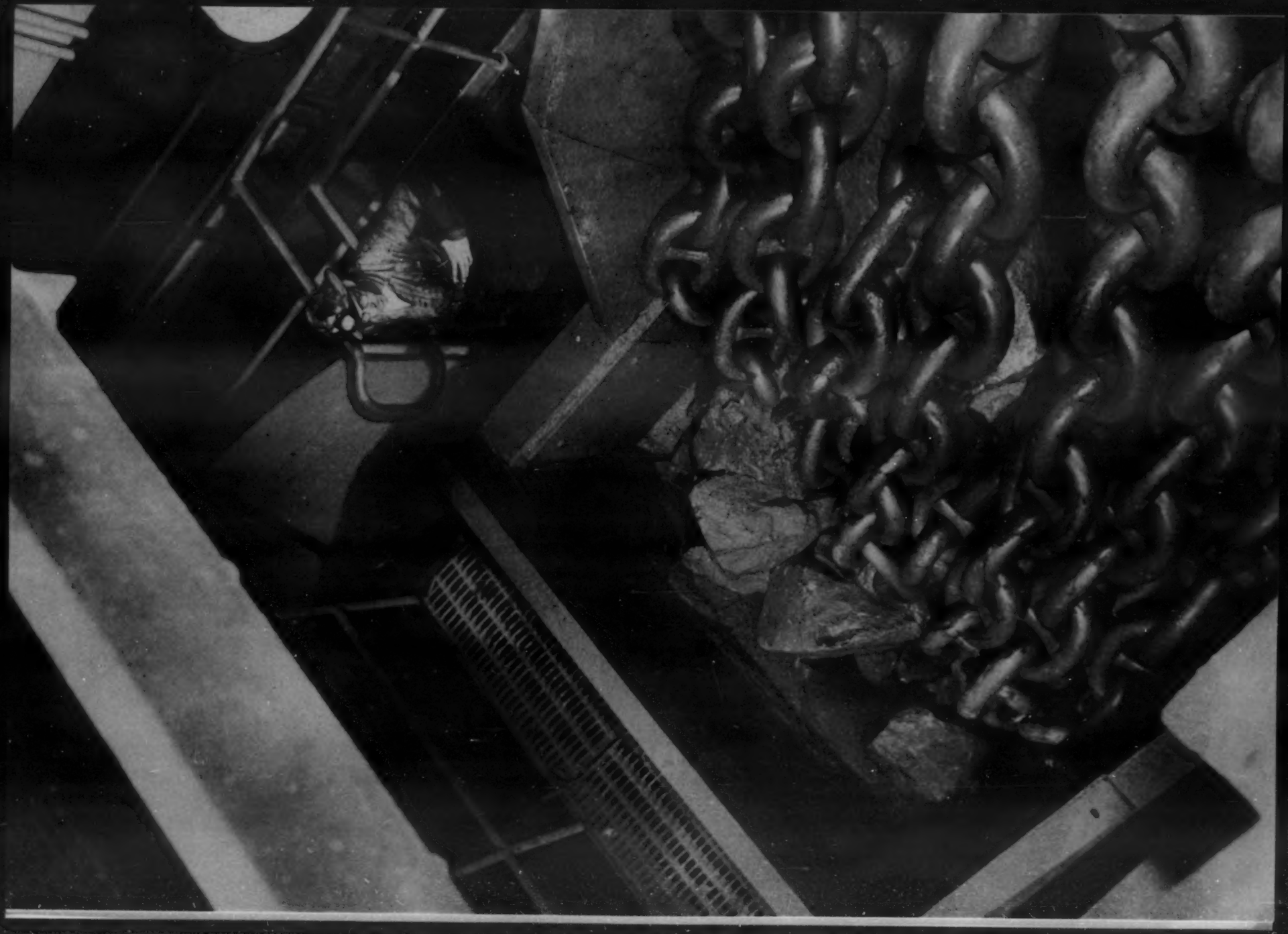
Haulage problems arising from the handling of high tonnages of ore of differing grades in Sweden's underground iron ore mines has led to the adoption of automatic signalling and routing system with a central traffic control room. Data processing machines are being considered for use underground to aid in better utilization of rail haulage equipment.

A recent development of cage raising overcomes the requirement for expensive hoisting machinery and need for a hoistman. Called the "JORA cage method", the hoist is located in the cage itself where it can be operated by the miners.

Overall advance per manshift using the JORA method of raising is approximately 7 ft, including the time required for drilling a 5-in. diam pilot hole. At present only vertical or near-vertical raises can be driven from cages, but a special unit for inclined work is planned.

CONCLUSION

It can be justly claimed that the European hard-rock mining industry in recent years has been responsible for many important developments in equipment and techniques of substantial benefit to the mining industry. With no slackening in the general tempo of drive and enthusiasm, more European "firsts" are anticipated in due course.



ANNUAL REVIEW

MINERALS BENEFICIATION

INTRODUCTION

STEPHEN E. ERICKSON
Hibbing, Minn.

The past year, when reviewed in regard to Minerals Beneficiation, can be characterized as a year of consolidation and development rather than as a year in which significant advances have been made in the fields of minerals beneficiation. The situation is probably related to the business recession of 1958, the steel strike of 1959, and the uncertainty of business conditions in 1960. Nevertheless it appears to be timely to repeat the warning contained in Dr. Nathaniel Arbiter's annual review for 1958 in which he stated; "We in the U.S. are doing significant bread and butter development work which will maintain an improved efficiency of operation and contribute to progress. But loss of leadership in the research field and in the probably diminishing supply of beneficiation engineers can have serious effects in the economic and political struggles which face us."

There have been many advances in process technology and it is of much interest to note how rapidly the frontiers of mineral beneficiation are being pushed into fields that in past years were considered as separate disciplines. Chemical engineering was once somewhat alien to the mining industry, but now we are seeing that some of the more significant recent advances have come from the application of chemical processing methods to minerals. For example, consider uranium recovery methods and the processes that are being developed for tungsten, columbium, the rare earths, and other similar metallic ores.

Pyrometallurgy was once far removed from ore beneficiation, but now it is rapidly becoming an integral part of the mineral beneficiation field. Magnetic roasting of iron ores has been revived as a beneficiation process and, even closer toward pyrometallurgy, it is noted that the R-N process, the Krupp-Renn process, and other direct reduction processes are now part of the stock in trade of the beneficiation engineer. Further, it is significant to note that the beneficiation engineer must now also concern himself with such methods of preparing fine concentrates for market as briquetting, sintering, pelletizing and other agglomeration processes that are being adapted to the mineral fields.

More directly in the mineral dressing fields, the most interesting recent test work appears to be in the field of autogenous grinding. Here the principal contenders at present appear to be the Aerofall mill and the Cascade mill. With the interest in this subject it would appear that we can expect some noteworthy advances in grinding techniques in the next few years. One effect of the autogenous grinding test work that already appears to be influencing conventional grinding methods is the trend toward larger diameter ball mills.

In iron ore processing, the revival of interest in dry magnetic separation, electrostatic separation, and in ultra high intensity magnetic separation should lead to improvements that can probably be applied to the processing of minerals in addition to those that are normally considered to have magnetic properties.

As will be noted in the process reviews there also appears to be a revival of interest in the older methods of gravity concentration. The principles remain the same, but the processes, procedures, and apparatus are now being dressed in the most modern fashion complete with instrumentation and possibly even automatic control.

The application of instruments for operating control of mineral beneficiation processes continues to be a subject that fascinates and intrigues most mill men. Here again is an example of borrowing technology from the chemical engineers. It is true of course that wide spread adoption of automatic control has not proceeded as fast as many had hoped, largely because it has now become apparent that the average mineral beneficiation process has more dependent variables and more physical handling problems that must be solved. Nevertheless, good solid headway is being made in the field of operating control of mineral beneficiation plants. It now appears safe to look forward to the early design of an almost totally automatic concentrator.

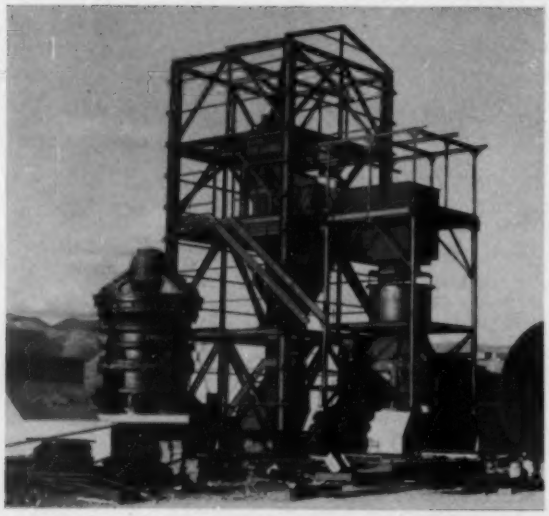
The future of mineral beneficiation looks bright. Much future improvement in efficiency and economics will develop as a result of the adoption and consolidation of procedures and equipment from other engineering disciplines. The disturbing facet of the mineral beneficiation picture is the recent tendency to look to the Old World for research and basic developments. If it weren't for this dark shadow there would be little reason for not considering this decade as the "Soaring Sixties" of mineral beneficiation.

We commend to the reader the following detailed records of our accomplishments in mineral beneficiation during the past year and hope that the grains of insight gained may inspire future mineral beneficiation progress.

Annual Review—Minerals Beneficiation

MILL DESIGN

A. A. WALLACH
Kaiser Engineers



Among the mills now being designed and built in the U.S., Inspiration is presently constructing a 4000-tpd plant at its Christmas mine in Arizona. Shown above is a recent view of the 60-in. gyratory crusher installation.

1960 has seen an increase in the number of basic processes covered by the field of mill design. The inclusion of chemical processing, developed to a fine degree in the uranium milling industry; the inclusion of roasting, a normal pyrometallurgical process as a beneficiation tool; and further treatment of concentrates, as evidenced by agglomeration requirements in the iron ore industry, have all widened the field of mill design activities.

With the large capital investment required for the mammoth mining projects currently being developed, there is an increased emphasis on sound planning and well-engineered plants. The trend toward larger and larger individual units is continuing in the crushing, grinding and classification processes. This necessitates thorough, detailed analysis of the economics of these large units for each new installation designed.

It is no longer necessary to work completely from theory in order to utilize the biggest primary crushers now available to mill designers. There has been sufficient installation of these units for compilation of the operating data so essential to efficient mill design. The construction of a 10-ft diam cone crusher has been disclosed by a major manufacturer in this field. This development indicates that secondary and tertiary crushers will keep pace with the increased tonnages that are now being produced or anticipated.

The installation of increasingly larger conventional grinding units is continuing and has reached the point where twin drives and motors are being applied efficiently. The 18-ft diam autogenous grinding mills installed by Quebec Cartier Mining Co. are already being overshadowed by the plans of two additional Canadian iron ore producers to utilize 22-ft diam mills. There are rumors that 30-ft mills are already on the drawing boards.

In the field of classification, the mill designer is no longer restricted to choice of one of a small number of mechanical classifiers. He can now substitute or supplement these through the use of applicable high speed screens and liquid-solid cyclones.

The development of more efficient concentrating devices in the gravity, electrostatic, and magnetic fields requires detailed engineering studies by mill designers to supplement metallurgical test work performed by operating companies and research groups for the selection of the optimum process for any individual installation.

The disposal of mill tailings, previously a stepchild in preliminary mill design, may now and in the future be "the tail that wags the dog." The rugged, climatic conditions encountered in the localities of major new developments affect tailings disposal to such an extent that the determination of the concentration process most economical for an individual plant may hinge upon the most economical tailings disposal method possible. The resurgence of gravity concentration with subsequent coarse tailings has resulted in many problems not heretofore encountered by the design men.

The possibility of shipping tremendous tonnages of concentrates extreme distances has required the utilization of more efficient concentrate dewatering devices and the installation of drying equipment to a degree not normally evidenced in the past in this field. The location of agglomerating plants at the mine, at an intermediate point, or at the point of final use requires comparative cost estimates and detailed study.

The increased application of instrumentation in operating plants—balancing of crusher circuits at Duval Copper, density control in the potash plants, continuous assaying in copper plants, etc.—allows the engineer to incorporate these and other advances in the design of new concentrators without encountering the resistance from operating personnel prevalent just a few years ago.

As a result of the new trends in mill design, specialists in these fields have been, of necessity, incorporated into mill design groups. The dissemination of information has become increasingly important, as has the application of operating results in design. The effects of these trends in mill design will minimize the capital investment required for new plants without sacrificing metallurgical efficiency or unduly increasing operating costs.

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CRUSHING AND GRINDING

FRANK WINDOLPH
Climax Molybdenum Co.

There has been continued interest in large diameter ball mills during 1960. The 12.5x16-ft, 1500-hp ball and rod mills at the Duval mill are performing as predicted. In the autogenous mill field there is a report of a 22x7-ft mill grinding lead ore in one stage at the Vassbo concentrator in Sweden, and Quebec Cartier Mining Co. selected 18-ft diam Cascade mills for its Lac Jeannine iron ore plant.

Most of the large plants completed or announced have used rod mills in the flowsheet to bridge the gap between crushing and ball milling. There now seems to be pretty general agreement on the merits of the rod mill for the normal grinding problem. The Mindola mill of the Rhokana Corp. has reported a switch from ball milling to rod milling by replacing 8-ft diam ball mills with 12-ft diam rod mills and eliminating the tertiary crushing section.

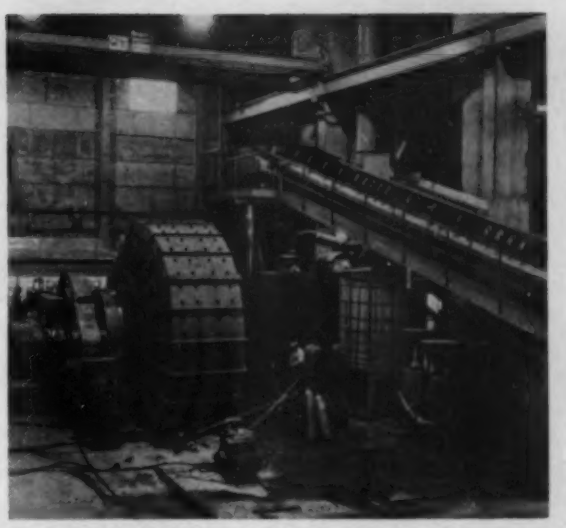
Autogenous grinding seems to be gaining interest from year to year, particularly as applied to iron ore. The autogenous mill has definitely been successful in approaching grain boundary comminution, which is the ultimate in mineral liberation.

There is a continuing drift toward wet cyclone classification. Circulation loads in the 1000-pct range using cyclones are being investigated in Africa. The high circulating loads are easier to achieve with cyclones than with mechanical classifiers, and there seems to be enough difference in classification with cyclones to justify probing into the high circulating load field again.

There has been increased application of automation and centralized control in crushing plants in order to fully utilize the design capacity of equipment and to eliminate damaging overloads. Open crushing circuits are proving to be cost savers wherever they can be used.

Automatic grinding circuit control development continues, and the water balance and thermal differential methods of maintaining the proper ball mill density, as reported by Norman Weiss, should be carefully considered. The positive control of the pulp consistency within a ball mill will produce a significant improvement in the grinding efficiency of such units.

The Toquepala plant went on stream and has three stages of crushing plus 10x14-ft, 800-hp rod mills and 10.5x13-ft, 800-hp ball mills. Mechanical rake classifiers were installed in the first and second stages of grinding. The 8x13-ft regrind mills are in closed circuit with hydrocyclones. The El Salvador development also has three stages of crushing, 10x 14-ft rod mills, and 10x14-ft ball mills. The rod mills are in closed circuit with spiral classifiers and the ball mills are operating with wet cyclones. The crushing and grinding equipment in these operations is performing as designed, and the plants are a real tribute to those who had a part in the planning and design.



The 22x7-ft grinding mill at the Vassbo concentrator.

Several good papers on energy-size reduction relationships were presented at the 1960 AIME Annual Meeting. Fred C. Bond has advanced "Three Principles of Comminution" to determine the correct relationship between useful energy input and the product particle size made from a given feed size. These professional contributions to the literature should result in a more universally accepted comminution theory.

The third International Mineral Processing Conference held in London also produced some noteworthy papers on comminution. R. T. Hukki has extended his study of ball mill grinding at supercritical speeds. He stated that if a conventional grate mill using steel balls was increased to 100 to 120 pct of critical speed, the same capacity and power input should be obtained with an autogenous grinding medium. He also observed that the maximum capacity of a given mill has always been in the supercritical speed range in his pilot plant tests.

The progress of crushing and grinding knowledge has been slow but sure during this last year. Operators have done a notable job of obtaining the utmost efficiency out of existing equipment. This steady advancement is necessary to make the metals recovered from our low grade mineral deposits competitive with other materials and metals from foreign markets. Crushing and grinding costs have been reduced in many cases by the use of industrial engineering techniques applied to all phases of operation and maintenance. Some progressive organizations are studying the use of electronic computors to solve the elusive problems of operations research and design of equipment and flowsheets.

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CONCENTRATION

E. C. TVETER
The Dow Chemical Co.

Few developments in ore concentration can be attributed to a particular year, and no single item stands out in 1960 except perhaps the new process for beryllium flotation announced by Dynamic Metals Inc. Nevertheless, continuing progress is evident in both the theory and practice of concentration. Major emphasis during the year has been on the latter with increasing use of automatic controls, cyclone classification, middling regrind circuits, and application of old separation processes to new problems.

Stream pollution problems and water shortages with increased mill tonnages have resulted in traction thickener installations at several plants. At Kennecott's Hayden operation the thickener underflow density is controlled by radioactive isotope radiation measurement (AccuRay Control). Similar equipment is being used to control flotation pulp and cyclone overflow density at Inco's $12 million Levack mill.

Reagent feeding practice is undergoing a changeover with a number of mills now using either flowraters or time-modulated pulse feeders. The pulse feeders are readily adapted to remote control and have replaced conventional reagent feeders in a number of plants, including Anaconda where they are used for frother, collector, and lime slurry feeding. Several plants are reportedly considering coupling of the reagent feeders to the ore feed rate for automatic reagent control.

Cyclones continue to replace mechanical classifiers and are employed in almost all middling regrind circuits. Major emphasis is also being given the use of cyclones as concentrators, using either dense media or heavy liquids as the fluid.

PROCESS DEVELOPMENT

Renewed interest in heavy liquids for mineral separations resulted from the work reported by Israel Mining Industries Laboratories at the International Mineral Processing Congress in London. Although tetrabromoethane and similar heavy liquids are frequently used in laboratory separations, little effort has been made to apply them commercially. The improved recovery techniques and the availability of tetrabromoethane at lower prices is now making its use in commercial applications potentially feasible.

The segregation process for the recovery of "oxide" copper reached the commercial stage in the 250-tpd plant of Transarizona Resources at Casa Grande, Ariz. This plant is reportedly chloridizing and reducing 2 pct copper ore to produce elemental copper and floating the copper as a 45 to 50-pct concentrate. It is expected that production of the plant will be expanded to 1000 tpd in the near future.

Pilot plants have been constructed on the Mesabi Range by M. A. Hanna Co. and the Oliver Iron Mining Co. to concentrate semi-taconites by magnetic separation following reduction roasting in kilns.

Beryllium flotation also entered the pilot plant stage in at least two projects; spodumene tailings were treated by the U.S. Bureau of Mines at Foote Minerals' Kings Mountain mine in North Carolina and the Mt. Topaz ore in Utah was treated by Dynamic Metals Inc. This latter operation involves the flotation of a yet undefined mineral from a complex ore. The process was developed by E. Van Dornick who anticipates a recovery of 80 to 90 pct of the beryllium in a 12 to 14-pct BeO concentrate. Concentrates assaying 40-pct BeO have been produced with good recovery from phenacite ore. If such concentration can be achieved economically, it will very probably represent the outstanding new development of the year in mineral concentration.

Pyrochlore flotation moved closer to commercial operation with at least two processes being carried through the pilot plant stage. The St. Lawrence Columbium & Metals Corp., Oka District, Quebec, employed a combination of gravity and flotation to obtain 50-pct Cb_2O_5 concentrates with over 80 pct recovery from a 1-pct pyrochlore ore. Preliminary concentration on Deister tables rejects 75 to 80 pct of the ore weight, and the table concentrate is being treated in successive stages of pyrite and calcite flotation followed by tabling and pyrochlore flotation. A somewhat different process by Columbium Mining Products is reportedly in the pilot plant stage at the Canadian Dept. of Mines in Ottawa, but details are not available.

An unusual application of cyanidation is employed at San Manuel Copper Corp. where gold is recovered by a cyanide leach of the molybdenum concentrates. This is believed to be the first reported example of gold recovery from molybdenum concentrates, and excellent recoveries are made.

Germanium recovery by magnetic separation became commercial at Union Miniere Du Haut-Katanga where magnetic germanium concentrate is removed from the rougher copper concentrate by intermittant Ferro Filters.

A new process for chrysocolla flotation was reported by N. A. Jaekel and W. C. Aitkenhead. It involves the use of sodium phosphate as an activator with stearic acid–kerosene–soap emulsion collector. Although collector consumption was quite high, the effect of 1.0 lb per ton of phosphate was notable in raising concentrate grade from 4.7 to 12.7-pct Cu

The concentration plant under construction at Asarco's 15,000-tpd Mission Project as it appeared in early December.

and increasing recovery from 52.6 to 90.4 pct. These results were obtained on chrysocolla samples from Inspiration Copper Co. If collector consumption could be reduced, this would represent a new approach to "oxide" copper recovery problems in the Southwest.

Rutile and zircon recovery from Australian beach sands using air tabling was studied by the CSIRO and the University of Melbourne (Report No. 589). Good quartz-zircon separations were obtained with coarse zircon, but the presence of fine zircon and increased quartz content impaired the selectivity of the process.

A detailed study of the effect of temperature on soap flotation of iron ore was made by S. R. B. Cooke, I. Iwasaki, and H. S. Choi. The results demonstrated that elevated temperatures improved the selectivity of iron flotation with all the fatty acids investigated. Major factors contributing to this improvement were considered to be 1) the accelerated rate of flotation of iron oxides, 2) decrease in floatability of quartz, and 3) more selective frothing characteristics at the higher temperatures.

An effective and unique gold-arsenic flotation separation was developed at the small (200 tpd) Marietta, Mont., mill of Northern Milling Co. The ore contains galena and native gold in a massive sulfide gangue of arsenopyrite and pyrite. Rougher flotation is conducted in a soda ash-sodium sulfite pulp using Z-6 xanthate collector. The concentrate is cleaned with potassium permanganate (0.05 lb per ton) as the arsenopyrite depressant. Close control of the Z-6 and $KMnO_4$ is reportedly required, but good selectivity is obtained.

Recent publications from the USSR show considerable work being done with sodium sulfite and sodium sulfide in the flotation of nonmetallic minerals. Except as a sulfidizing agent, sodium sulfide has received little attention in U. S. flotation practice. Its utility was demonstrated by W. R. Wade at Minera Buenavista (Cuba) in the treatment of a sulfide copper ore containing water soluble copper. The Na_2S not only precipitated the copper and made it floatable, but also, when used in slight excess, replaced the cyanide or sodium sulfite previously required as a pyrite depressant.

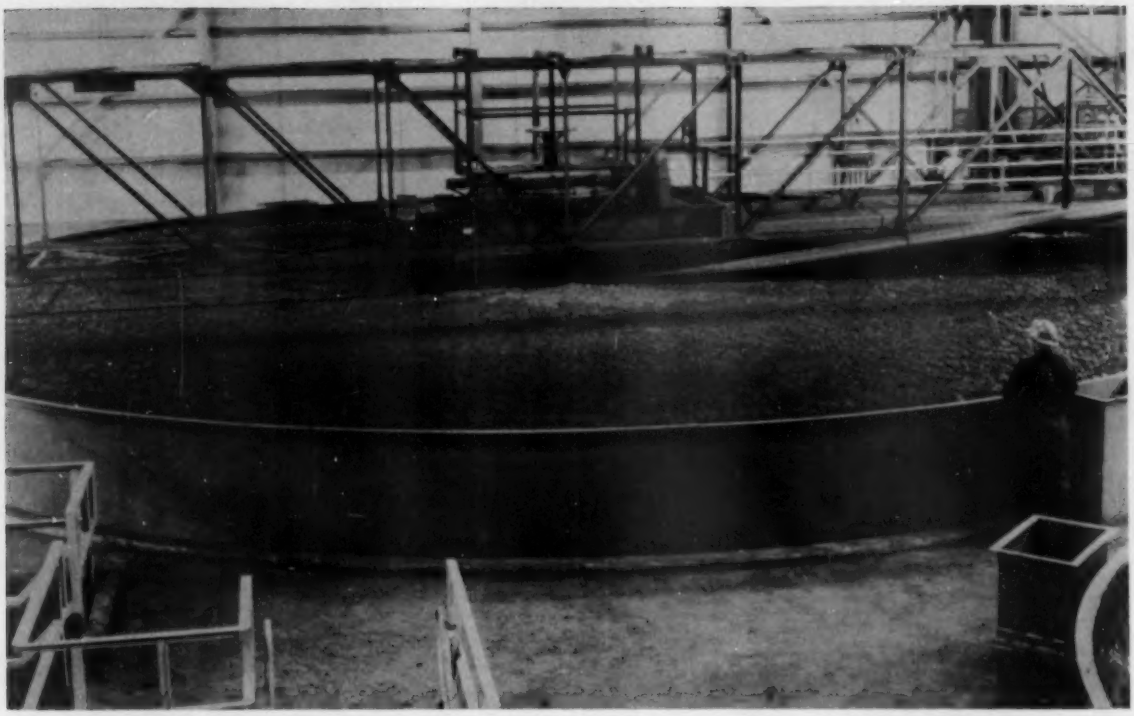
The factors affecting lead-zinc selectivity were studied by M. Rey and V. Formanek. They concluded that all zinc depressants known have only moderate effect as compared to the mineralogy of the ore (including the gangue minerals, soluble salts, and type of grind used). O. S. Bogdanov (USSR) specifically investigated cyanide as a depressant and proved that cyanide ion adsorption is of practically no importance. The important function of cyanide in depression of minerals was concluded to be due to the formation of the highly soluble copper complex $KCu(CN)_2$.

NEW CONCENTRATION PLANTS

Major expansion in copper, iron, and phosphate ore concentration is underway throughout the world. Asarco's new 15,000-tpd Mission Unit concentrator near Sahuarita, Ariz., is scheduled for completion in September, 1961, and will feature automatic control of many operations. It will include three-stage crushing followed by rod and ball mill grinding with cyclone classification. The flotation flowsheet proposed represents the recent trend in copper flotation practice in that the rougher concentrate will be reground, thickened, and cleaned with the cleaner tailings being refloated to produce a scavenger concentrate and tailings for discard. The scavenger concentrate will join the rougher concentrate. Other copper concentrators under construction include Anaconda's 5000-tpd flotation plant at Yerrington, Nev., Inspiration's 4000-tpd mill at Christmas, Ariz., and conversion of Pronto Uranium's mill in Ontario.

The new 6000-ltpd lead-zinc mill now being designed for Mount Isa Mines, Queensland, Australia will make the entire existing mill available for copper ores. The new facility is designed in two sections, one of which will also be able to take copper ores if desired.

Magnetic separation will be applied to beneficiation of finely ground western iron ores for the first



Inco's Levack mill uses 60-ft diam tray thickeners with a maximum 18-ft depth to dewater the nickel concentrate.

time in the U.S. Steel Co. plant under construction at Atlantic City, Wyo. This plant will produce 4000 tons of pellets per day from ore averaging 30 pct Fe. Utah Construction & Mining Co. is also building a 3000-tpd beneficiation plant at its Iron Springs mine in Utah and will employ magnetic separation on rod mill-ground ore. Iron flotation will enter the Minnesota field with the completion of Jones and Laughlin's Hill Annex mill near Calumet. Cleveland-Cliffs Iron Co. has also announced plans for expanding the iron flotation plant at the Republic mine in Michigan to more than double present production, and Marcona is building South America's first iron beneficiation plant. This latter mill will include both sink-float and magnetic separation sections. In Sweden a new 500-tpd plant has been started by Norbergs Gruvforvaltning. Here, selective flotation is employed to float an apatite concentrate, followed by the iron flotation with tall oil.

Phosphate flotation continued to expand in Florida and during the year entered two new fields. Negev Phosphates Ltd. installed a flotation plant in the Negev Desert (Israel) to beneficiate a calcareous apatite ore, and Compagnie Senegalaise des Phosphate de Taiba installed a 6000-tpd plant in the Republic of Senegal. This latter plant treats a 29-pct P_2O_5 ore by anionic flotation to produce a 38-pct P_2O_5 concentrate. San Francisco Chemical Co. which pioneered flotation of western phosphate rock is now building a new flotation plant at Vernal, Utah, to produce 200,000 tons of concentrate per year.

NEW EQUIPMENT

In the field of new equipment, the Humphrey's Engineering Co. has announced a counterflow sizer to be used in conjunction with its spiral. This apparatus has been in limited use for several years but has only recently been available for general sale. The sizer removes coarse particles of high gravity concentrate ahead of the spiral. Its use could possibly eliminate jigs or other coarse gravity concentration devices which might otherwise be necessary in conjunction with the spiral.

A new pneumatic flotation machine has been specifically designed for phosphate flotation by C. A. Hollingsworth of Smith-Douglass Co. Aeration is obtained from multiple horizontal grids of air pipes in the machine. Pilot plant operation of the Hollingsworth machine has reportedly shown an advantage in flotation of silica from phosphate rock using amines in the primary float, rather than the standard primary float with anionic reagents.

A unique magnetic valve for use in sink-float separations was described by P. Moiset and R. Dartois at the International Mineral Processing Congress. The unit provides a controlled magnetic field around the underflow which acts on the ferro-magnetic media to form a plug with a weak center through which the nonmagnetic concentrate can flow.

A new type of electrostatic separator employing an alternating-current field has been developed by Mastas Separators Inc. One model exhibited at the 1960 American Mining Congress Show resembled a standard shaking table and had a riffled deck. This particular model was designed primarily for cleaning operations. Other developments in this field include the Joy-Carpco separator designed for iron ore treatment.

Other examples might be cited of the continued progress in extending the efficiency and scope of mineral concentration. Although each new mill designed contains some improvements over its predecessor, the more obvious developments involve treatments of new types of ore minerals. The effectiveness of intensive research on a specific problem is especially demonstrated by the progress during the past few years in the concentration of columbium and beryllium.

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SOLIDS-LIQUID SEPARATION

CLYDE E. OSBORN
Homestake-New Mexico Partners

At times it seems that the techniques of Solid-Fluid separation have reached a point of saturation. Then, when one reviews the subject, it becomes apparent that this is not so. There is a constant striving for new or improved methods, for improved additives for flocculating and deflocculating, and for new and improved equipment.

The standard thickening and filtering applications for solid-liquid separation have now been supplemented by cycloning, centrifuging, agglomeration, flotation, ultrasonic vibration, and electronic processes in the mineral industry.

The efficiencies required for removal of solids from liquids in uranium ore processing plants range from pre-coat filtering that produce liquids with one-half part of solids per million parts of liquid with particle size of less than one-half micron, to cycloning which accepts solids up to 100 gpl at twenty micron particle size.

Studies, supplemented by plant scale tests, on the use of froth flotation for clarifying solutions are proving the technique feasible where moderate clarity is needed. Experiments with fatty acids and kerosene-glue combinations have solved a problem of removing suspended carbonaceous particles and finely suspended clay particles at one plant.

The use of ionic flotation reagents presents an interesting area for research and testing.

The equipment manufacturers are expending considerable effort and monies in developing better thickeners, better filters and types of filters, better filter media, and training men to do a better job of consulting and servicing.

Reports from the manufacturers of filter aids indicate advances in this field. More filter aids of better types are being developed for use in the mineral industry with greater emphasis on special materials for special jobs.

CHEMICAL PROCESSING

F. T. DAVIS
Colorado School of Mines Research Foundation, Inc.

Lithium: A sulfuric acid method for lithium extraction developed by Basic Atomics Inc. is being evaluated by the Texas Gulf Sulphur Co.

Recent lithium process patents included a Canadian patent (No. 596,302) on a pressurized caustic leach method, and a U. S. patent (No. 2,931,703) on a calcining procedure for recovering lithium from dilithium phosphate or similar materials.

Beryllium: Process information by Beryllium Resources Inc. indicates that the beryllium ores from the Topaz Mountain area of Utah can be processed by a combination method. The lime, silica tuff and fluorine compounds are removed by flotation, and the beryllium is extracted from the concentrate by an undisclosed multi-stage acid process.

The water insolubility of beryllium basic acetate is the basis for a new purification procedure developed by the General Electric Co.

Sodium Carbonate: A new process is to be used by the Chlor-Alkali Division of the Food Machinery and Chemical Corp. to produce needle-like soda ash crystals which will have less dust and good flowing characteristics.

Aluminum: Several acid processes for extracting aluminum from shales and other aluminum bearing materials were announced during 1960.

A pilot plant operation by Strategic Materials Corp. handled a high temperature acid leach at 400°F. This process was designed to recover alumina from mine wastes which contain 15 to 25-pct Al_2O_3. Corrosion introduced by the acid leach liquors in this type of process is considered to be a very major problem.

A French patent (No. 1,210,068) indicates that a process used by Aluminium Ltd. is a combination electrolytic-chemical method designed to bypass

the conventional bauxite-alumina-aluminum metal route.

Phosphates: The Mexico Mining Development Commission, a branch of the Mexican government, announced the development of a method for processing low-grade domestic phosphate rock. The calcium carbonate content of the rock is reduced by a combination of calcination and hydration steps.

Israel Mining Industries Laboratories has developed a solvent extraction process for separating phosphoric acid from calcium chloride, thus making it feasible to use waste hydrochloric acid for the production of phosphoric acid from phosphate rock.

Sulfur: A 208-tpd plant using superheated water for extracting sulfur from low grade volcanic ores was scheduled by the Catalytic Construction Co. for construction in Argentina.

A patent on a hot fuel oil method for processing sulfur-bearing ores was granted to the Delhi-Taylor Oil Co.

Potassium: Southwest Potash Corp. plans to build a facility at Vicksburg, Miss. for producing potassium nitrate from potash.

Titanium: A "cold" chlorination method for processing ilmenite is in the development stage at the Armour Research Foundation. The process produces titanium metal, titanium dioxide, and titanium tetrachloride.

The U. S. Bureau of Mines has reported work on a low temperature chlorination procedure without separate distillation steps for recovering both titanium and columbium from columbium-bearing ilmenite concentrates.

Vanadium: Mineral Engineering Co. plans to build a refinery at Salt Lake City to produce vanadium pentoxide from a ferro-phosphorus slag byproduct which is made during the manufacture of elemental phosphorus.

Manganese: The Standard Metals Corp. has announced plans to build an electrochemical plant that will recover manganese from a rhodonite concentrate produced at its Sunnyside mine near Silverton, Colo.

Iron: Sherritt Gordon Mines Ltd. has been granted a Canadian patent (No. 597,512) on a nitric acid process for producing high purity ferric oxide from laterite, ilmenite, and other materials, and it involves nickel and cobalt recovery.

Nickel: Republic Steel Corp. obtained a Canadian patent on a two-step chloridizing process for recovery of nickel values from laterites, serpentines, and similar nickel-bearing rock.

Allis-Chalmers announced a nickel-cobalt separation method based on the volatilization of certain organo-metallic compounds.

Copper: Empressa Minerva de Mantos Blancos planned to place its new 3000-tpd plant for treating basic copper chloride ores in operation during the last half of 1960. This new plant will pioneer a patented acid leach process which utilizes sulfur dioxide to precipitate cuprous chloride from the leach solutions.

Zinc: A cyanide leaching process for extracting copper from zinc concentrates was reported by American Cyanamid Co.

Gallium: The Dow Chemical Co. applied for a patent on a volatilization process for recovering gallium from bauxite ores by contacting the ore with HCl or HBr at 700° to 900°C. The volatile gallium halides are condensed and dissolved in water.

Columbium and Tantalum: The Wah Chang Corp. reports that their solvent extraction circuit is successfully separating columbium and tantalum. High grade columbite-tantalite ores are digested in hydrofluoric acid leach solutions and then extracted with hexone in pulse columns. The tantalum is extracted into the solvent phase and the columbium remains in the aqueous raffinate.

Tungsten: A paper on the autoclave-soda process for the treatment of tungsten concentrates (similar to Union Carbide's Bishop, Calif., process) was presented by N. N. Maslenilsky of Russia at the International Mineral Processing Congress in London.

Since February of this year, Union Carbide's tungsten mill at Bishop has been producing commercial quantities of high purity ammonium paratungstate. This operation is based on a new process developed by the Corporation, and is the first known direct method for preparing a high purity product from scheelite ore. During the year this output and the quality of the product (e.g., it contains less than 0.003 pct each of molybdenum and silicon) has contributed significantly as a raw material for the manufacture of cemented tungsten carbides, lamp filaments, numerous electrical applications, and development requirements for missile components. A 25 pct increase in capacity is planned by the company for the latter part of 1961.

Gold: The Golden Cycle Corp. is now using a specially designed electrolytic cell to recover gold in the finishing step of their "char-in-pulp" cyanide process.

Ion exchange of gold from cyanide solutions is being studied at Teddington, England, under the sponsorship of the National Research Development Corp.

Lead: A new amine leach process for producing silver-free high purity lead from lead sulfide ores was described by F. A. Forward at the International Minerals Processing Congress. The process is based on the extraction characteristics of alkaline amine solutions for lead, together with the selective precipitation of basic lead carbonate from these solutions.

Uranium: The corrosion problems in the alkaline leach circuits at the Beaver Lodge uranium operation were traced to the reactions of sulfide minerals in the ore, and a flotation circuit is now in operation for removing these minerals.

Imperial Chemical Industries Ltd. has been granted a U. S. patent (No. 2,945,741) on a process for precipitating uranium from phosphoric acid liquors with sulphoxylic acid derivatives, such as sodium formaldehyde sulphoxylate.

The New Mexico Institute of Mines and Technology has conducted successful laboratory flotation of ion exchange resins from ore pulps. Uranium, rare earths, and base metals have been involved in this work.

Ion Flotation or Foamet Process: Radiation Applications Inc. has completed two years of work on the foam fractionation or ion-flotation technique. The latest development is based on incorporating metal ions into an organo-metallic complex which also has a surface active site. This surface activity allows the complex to collect at the interface of bubbles introduced into the solutions containing the complex organo-metallic ions. The technique appears to have particular application for concentrating metals from dilute process streams.

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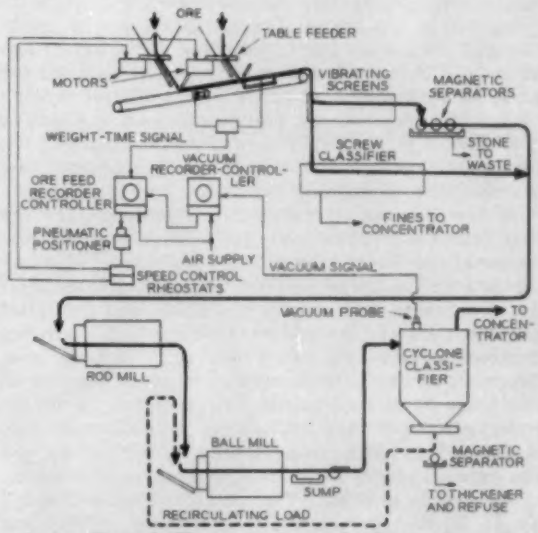
OPERATING CONTROL

L. A. ROE
International Minerals and Chemical Corp.

The term operating control *is becoming more and more synonymous with* computer control *when applied to American industries. The mineral industry is no exception. The author cites a variety of computer installations, with additional supplementary information contained in the next article.*

The passing of another year in the transistorized-printed circuit-space age has witnessed an increasing rate of application of automatic controls and computer controls to steel mills, chemical plants, oil refineries, and power plants. The minerals industry continues to lag in the application of automatic controls to its processing plants. However, the bright spot on the minerals industry horizon is the increasing use of instrumentation in almost all of the new minerals plants built or under construction during recent years. This augurs well for the future since a more detailed and more accurate history of process variables can now be developed. The ease of conversion of a minerals plant from manual to automatic control is directly proportional to the degree of instrumentation used and the efficiency of process record keeping.

An eastern iron ore beneficiation plant has installed a unique control system that maintains optimum loading of its grinding circuit. The system operates on changes in the vacuum developed in the vortex of hydrocyclones used as classifiers. (See diagram on this page). If the crude ore fed to the rod mill increases in hardness, the recirculating load in the grinding circuit increases to a degree measurable in the change in vacuum in the hydrocyclone. Vacuum signals from a probe in the cyclone are fed to a vacuum recorder-controller where output controls the setting of an ore feed recorder-controller. If the vacuum in the cyclone increases, a lower feed



rate is effected. The actual ore feed rate is sent to the ore feed recorder-controller by feedback from a resistance-type load cell and a tachometer on the feed belt. The composite signal of the load cell and the tachometer represents the actual rate of material flow.

In the same iron ore plant, the total tonnage of materials fed to the grinding system is recorded. By

use of an integrator in the ore feed recorder-controller, the feedback signal from the belt conveyor is converted into a form that can be displayed as cumulative tonnage on a digital computer. Tape printers are used to provide permanent records of production.

An outstanding development in computer control of a crude oil distillation unit attracted in *The Wall Street Journal, Chemical Engineering,* and *Chemical and Engineering News* during the month of October 1960. This breakthrough in controlling a complex process is the result of two years work by Standard Oil of Indiana and International Business Machines Corp. An IBM 704 computer reads 196 instruments every four minutes and types out orders every twenty minutes. These orders are based on 75,000 stored instructions. Upon receipt of the typed optimum settings, the operators make manual adjustments covering 19 key process variables.

The $15 million Monsanto Chemical Co. ammonia plant at Luling, La., has been computer-controlled since January 1960. The process control computer in use is the result of a joint feasibility study begun in 1957 by Monsanto and Thompson-Ramo-Wooldridge Computer Co. engineers. The RW-300 computer runs the 450 to 500-tpd ammonia plant in a fully-automated, closed-loop arrangement. Under manual operation, the operators estimated optimum equipment settings for highest ammonia output. With the new computer, precise adjustments result from automatically calculated instrument settings. It is expected that these control improvements will boost output six to nine pct and could pay out the $300,000 computer installation in about three years.

A feature of the Monsanto installation which will be of interest to minerals processing plants closely integrated with chemical and smelting operations is the fact that the RW-300 unit is used only 60 pct of the operating day for all control work. This means that adjacent ammonium nitrate, adipic acid, and nitric acid plants may be controlled by the same computer in the future. The computer can be easily "taught" to switch from one plant operation to another and thus extend its utility. It is not at all too early to begin plans on use of one computer to control continuous mining equipment, ore stockpiling and blending, beneficiation operations, chemical refining of concentrates, smelting operations, and warehousing of finished products.

A new continuous purification technique for the production of 99.99 pct pure NaCl from rock salt now in use at the Avery Island, La., mine of the International Salt Co. relies heavily on automatic controls for its success. The process was developed in a pilot plant at the company's Watkins Glen, N. Y., refinery before the full-scale plant was built in Louisiana. Magnetic flowmeters are used to measure the flow of hot brine at several points. Liquid levels in all atmospheric and vacuum vessels are automatically controlled, as is the temperature of the dryer air and the exhaust steam fed to a high-temperature heater.

An article entitled "Control of a Sinter Plant," by D. E. Hamilton and R. L. Houlton of General Electric Co. appeared in the May 1960 issue of *Automatic Control* magazine. The authors emphasize several factors which will apply to future improvements in the control of other types of minerals beneficiation plants. One of the most important is education of plant operators to the fact that they ". . . must document the science of the process including a knowledge of cause and effect relationships and of the measurements of product value. Machinery builders must continue to pay careful attention to plant design to make transport times as short and as equal as possible, to eliminate sources of mechanical disturbances, and to ease the problem of obtaining measurements of the process."

There is an encouraging trend in both wet and dry minerals processing methods to minimize material transport in the middlings area of the flowsheet. Some of the serious complications in automating a minerals processing plant may well be simplified by tearing away from the old concept that a middlings product must be treated in the same circuit as the new feed.

The sinter plant control installation described by Hamilton and Houlton will use a General Electric 312 digital computer which will initially be used as a data logger and eventually to control the entire process.

Another new development in the control of steel making facilities is taking place in the Great Lakes Steel Corp.'s new hot strip mill near Detroit. Here a Westinghouse PRODAC digital controller will control directly, instead of through punch cards. To emphasize the work this installation will do, note the following items:

To the computer:
113 temperatures
4 ratios (fuel-air)
63 pressures (water, stack, roll balance)
40 positions
12 speeds
4 product dimensions
1 weight

From the computer:
Speed controls
Screwdown settings
Alarms
Accounting data

In the Detroit installation, three companies are cooperating—Daystrom Systems, Westinghouse, and General Electric. As *Business Week* points out in a Nov. 5, 1960, article on this development, ". . . geting the bitterly competing companies to cooperate on this project may be the toughest control job of all."

The Ohmart Corp. reported on the first commercial nuclear gauge system for measuring the flow of granular material flowing through a pipe or chute in the Sept. 17, 1960 issue of *Business Week.* An installation at the Fairborn, Ohio, plant of Universal Atlas Cement Co. measures the flow of material falling down a gravity feed pipe into a kiln.

James R. Bright is the author of a soul-searching article for minerals engineers who recognize an area called "long range planning." The article is entitled, "Are We Falling Behind in Mechanization?" and appeared on pages 93 to 106 in the November-December 1960 issue of *The Harvard Business Review.* The readers of this review will note the emphasis on automation developments outside the minerals field. This is intentional and calls your attention to the fact that rapid progress is being made in other industries in the solution of some of the problems which have long been stumbling blocks to the application of automatic controls in ore processing plants. Crossbreeding of control ideas from the power, petroleum, and chemical industries to mineral industry control problems is a fruitful field of genetics.

ANNUAL REVIEW

MINING AND COMPUTERS

by RICHARD F. HEWLETT
University of Arizona

The growing interest among mining men in the potential applications of electronic computers in the mineral industry has warranted this special review. A brief look at the future of "computer-ized" mining accompanies this listing of computer uses by these companies–

- PIMA MINING CO.
- OLIVER MINING CO.
- RIVERSIDE CEMENT CO.
- KAISER STEEL CORP.
- U. S. STEEL CORP.
- POCAHONTAS FUEL CO.
- UNION CARBIDE NUCLEAR CO.
- PYROMETALLURGY LABORATORY
- FRESNILLO MINE

Today the mineral industry finds itself in another period of technological transition. In a sense, the present transition is unique because every mine, regardless of size, will directly or indirectly feel its effect. Moreover due to rising costs and increased competition, mining companies are now being forced to consider using the cause of this transition —electronic computers. Just as desk calculators and slide rules were developed because of the need to perform calculations faster and with greater precision, computers have been and are being developed to answer our present day needs for solving ever-increasing complex problems or for high-speed determinations of constantly repeating problems.

Inasmuch as this is the first such article to review the use of computers in the mining industry for the Annual Review Issue of MINING ENGINEERING, and because the use of such "electronic brains" as applied directly to mining problems is of very recent vintage and company use is as yet limited, applications, installations, and some of the experimental work occurring in the past two or three years, not just 1960 alone, will be reviewed.

MINING APPLICATIONS OF COMPUTERS

Pima Mining Co. engaged in an exploration drilling program to check the feasibility of expanding their open pit mine in southern Arizona about one year ago. The area for possible expansion was divided into equal increments proceeding outward from each bench in the existing pit. After the pertinent geologic and cost factors were determined, the company used a digital computer located at the Numerical Analysis Laboratory of the University of Arizona to calculate the economic limit of pit expansion. Results from the computer contained the following information for each increment:

1) Cubic yards of alluvium and waste rock to be removed.
2) Ore tonnage and average grade.
3) Direct mining cost.
4) Total cost.
5) Stripping ratio and total volume of material to be moved.
6) Value per ton of ore and net value of production at seven different prices of copper.

Totals for each increment were obtained as well as sub-totals by benches. In addition, the cumulative total of that increment plus all previous ones was shown. This allowed the economic limit of expan-

sion to be easily selected as it was at that increment where the net value sharply declined.

Oliver Mining Co. has a digital computer make some of the calculations for estimating ore reserves. This machine is employed to:

1) Average drill-hole analysis for each cross-section area.
2) Average the layer or grade by weighted area.
3) Calculate tonnage and cubic yards of material.
4) Calculate the combinations.

The company has also used the computer to aid in solving the following problems:

1) Survey traverse closure.
2) Calculation of forces applied to a retaining wall by trucks backing up to dump material.
3) Correlation of drill-hole data with slump of the orebody.

Riverside Cement Co. uses its process-control computer to calculate the amounts of available raw materials that will build a pile of the desired average chemical analysis for making cement. A mathematical method called *linear programming* is used to find an optimum solution to a problem which has a number of possible solutions. This method determines the lowest-cost combination of materials that can be combined to give a specified mix. Input to the computer routine are as follows:

1. Proportions of oxides desired in the mix
2. Chemical analysis
3. Cost of each raw material

There is usually a large number of sources available to permit numerous combinations of materials for the desired mix. Mix specifications can be given for a range or for an exact amount. Quarry operating personnel can then work out a schedule for hauling these materials to the plant.

Kaiser Steel Corp.'s engineers were calculating tonnages of the small Silver Lake iron deposit by conventional methods, when to speed the operation and serve as a pilot project, R. L. Wilson, geologist, and R. P. Bogart, senior programmer, decided to utilize a punch card machine and a printer for the computations.

Five steps were used in the calculations for ore and waste:

1) Summation of sample data within each drill hole.
2) Summation of drill-hole data in each section.
3) Summation of sectional data in each orebody.
4) Summation of orebody data in the total deposit.
5) Summation of ore grade of seven elements in the total deposit.

The ore volume was carried through the machine calculations and converted to tonnage by conventional means at the end.

Simultaneously, the planning for the 500 million-ton movement of waste and ore in the East Pit of Kaiser Steel's Eagle Mountain mine had been started. C. E. Davis, mine engineer, assisted in adjusting the Silver Lake program for the additional requirements of the larger pit. In general the two calculations were similar but the Eagle Mountain program was carried by summation of data on proposed mining benches, and as a final step, the complete data for each of the benches was consolidated for value in the total deposit.

U.S. Steel Corp. is using a digital computer in their coal operations for the following purposes:

1) Introduction of statistical quality control.
2) Development of production and equipment hour-standards for continuous mining machines.
3) Evaluation of the price-quality relationships of coals of various specifications.
4) Processing of coal washability data.
5) Development of annual district operating plan balances resulting from normal annual clean coal requirements of the various coke works.

Use of the computer and statistical quality control aids in obtaining optimum coal quality and consistency of product. The machine computes information with great rapidity so that positive and timely decisions can be made concerning the operation of coal washers, the blending of coals, and the burdening of blast furnaces.

This company is also reported to be considering use of computers to control blending and processing of ore at their mine sites.

Pocahontas Fuel Co. employs a computer for a more common purpose—supply cost reduction. Detailed supply cost data provide management with a foundation upon which it is building a cost-reduction program. Costs are analyzed from the total right down to individual items regardless of classification. These reports make possible the assignment of cost responsibility, and they also disclose where action is necessary to stay within objectives.

Types of supply reports made are:

1) Supply cost report
2) Supply cost report supplement
3) Supply cost comparison
4) Central shop overhaul report
5) Intra-company supply charges
6) Usage report
7) Stock status report
8) Purchase orders
9) Intra-company shipping orders
10) Colliery back-order lists
11) Inventory lists
12) Inactive parts list
13) Supply catalog list

The extra savings on supply, engineering, and statistical work are being realized at only a slight additional cost over original expenses.

Frisco and Fresnillo mines in Mexico supplied approximately 50,000 mine-sample assays for processing through other types of modern electronic business machines (calculating punch, sorter, tabulator) in a program investigating the applicability of such machines to handle assay data quickly, precisely and accurately. As reported in the September 1960 issue of MINING ENGINEERING, machine processing of key-punched cards containing information of vein widths, metal assays, mine coordinates, and elevation successfully provided the desired information of vein content at each location, combined base-metal assay, approximate sulfur assay, silver-zinc and lead-zinc ratios, and the combined base metals content at an approximate cost of 0.25¢ per sample.

Pyrometallurgy Laboratory of Bruceton, Pa., is the site of a somewhat different usage of computers. Some typical problems handled are:

1) Tabulations of thermodynamic properties.
2) Periodic analysis of experimental blast furnace operations.
3) Evaluation of unsteady state heat losses to furnace walls.
4) Characteristics of fluid flow and flame stability criteria in a new type of burner.

Tabulations of thermodynamic properties required six days at a desk calculator. Time required to program and compute the values was:

Metallurgical technologist .....1 day

Computer specialist ..... 2 hours
Computer time:
Test program ..... ½ hour
To compute 601 values ..... 12 minutes

Overall time saving reported was 80 pct and the cost saving was 55 pct.

Union Carbide Nuclear Co. makes use of electronic computers to solve routine surveying problems. The computer system is not only more efficient, economical, and accurate than manual methods, but it frees technical personnel for more constructive work, the value of which can only be measured in reduced cost of operations.

A series of computer experiments conducted during the past year dealt with four common problems in surveying.

1) Solving traverses closing on starting point.
2) Solving traverses which close between two known points; termed "open traverses with balancing."
3) Solving truly open traverses which have no closing point.
4) Solving elevations and coordinates of stadia shots.

Reported cost of calculating a stadia shot by manual means was approximately $1.00 vs. total computer and key-punching costs of $0.36. Similarly manual calculation cost per traverse station is $2.50 as compared to the computer cost of $0.36. It was also determined that $6.00 was required for surveying and computing manually a drill-hole location, but that the use of computers reduced this cost to $2.00 per hole.

Although the phenomenal speed of computers in calculating an answer is well-known, it is of interest to note that in one minute, the computer performed computations that would normally require 240 man-hours to make in solving the same surveying problems.

RECENT INVESTIGATIONS OF COMPUTER APPLICATIONS

Ore Reserve Computations: Preliminary results of comparisons of ore reserve computations made with drill-hole data from a mined-out portion of the Silver Bell Oxide pit with the actual production records were reported in the January 1961 issue of MINING ENGINEERING. Employing a digital computer for all of the computations, three different methods of combining the drill-hole data were analyzed—polygonal, triangular, and statistical methods. Although this work indicated the need of further data refinement, the results illustrated the excellent potential of such uses of computers. The combined effects of bench geometry and pit slope caused the tonnage to be overestimated and the grade to be underestimated when compared with the production records. These factors have been corrected and computations are presently being made for each bench. Further studies now being made to improve ore reserve determinations are the effect of assay errors, surveying errors, and assay intervals. The author is synthesizing mineral deposits for ranges of means and standard deviations and different degrees of trend. The simulated assays are being combined by the different methods of computing ore reserves to determine efficiency of sampling and evaluation methods. Different drilling grid spacings and shapes are used to help determine the minimum number of drill holes needed for different mineral deposits.

Geochemistry: The computers ability to make rapid, precise, and elaborate calculations has been applied to the field of geochemistry. In a recent research experiment for the radiometric determination of potassium (K^{40}), a computer was programmed to supply the following information:

1) Percentage of potassium (corrected).
2) Standard deviation of corrected percentage of potassium
3) Alpha particle count per minute.
4) Standard deviation of alpha particle count.
5) Beta particle count per minute.
6) Standard deviation of beta particle count.
7) Alpha count factor to correct for beta activity due to uranium and thorium.

Naturally the results from this machine (and all other computers) are dependent upon the program designed to guide the machine through the intricate steps required. In this particular experiment, the computer performed 25 calculations per minute, whereas hand calculations required 30 minutes each.

FUTURE OF COMPUTERS IN MINING

Routine problems have mainly dominated the types of applications made of computers in the mineral industry. Such problems are obvious at the mine site, and their programming can be justified as a cost-saving and time-saving item.

Presently, there is a definite trend for mining companies to make theoretical studies to help solve some of their problems. Involved are many elements of management science, operations research, and industrial engineering. This trend will be greatly accelerated in the future. Mathematical models of mineral deposits, mining operations, and milling circuits will be made and solutions found to many mathematically complex problems now encountered in the mineral industry. Utilization of a computer for such complex problems has the obvious advantage that the user of the computer program is not required to know in detail the mathematics or methodology used to solve the problem. A user of a big-game rifle is not required to know in detail how the rifle operates, only what the rifle can do.

Most mining companies will start investigating the use of digital computers by using the facilities of computer centers now located throughout the nation. Computer costs and advantages can then be accurately determined without capital investment. In addition to the aforementioned computer centers, there are several private consulting firms which provide complete computer service to the mining industry.

Many additional computer programs should be developed. The ultimate goal of all of these computer programs would be to design a mine, mine plant and mill from the exploration drill-hole data. This will enable rapid and accurate mine development and mine operating cost estimates to be made. Conceivably, this could be done in about one week with the aid of many computer programs.

Colleges, universities, and the U.S. Bureau of Mines will continue to play an important role in the development of computer programs for use by the mineral industry as a whole. A library of computer programs will be built up by these groups as well as by some mining companies. Having available computer programs to use is the key to computer utilization because the biggest expense is involved in developing the computer programs. Many computer programs have been developed by the U.S. Bureau of Mines, and more will be made available as they are developed.

ECPD, EJC and NSPE

PROGRESS REPORT OF THE AIME COMMITTEE

The October issues* of the Journals of the three AIME Societies carried a brief resume of the historical development of various technical and professional organizations which in some immediate or remote way affect the individual member of AIME. This resume was presented by the Institute Committee on Inter-Engineering Society Cooperation.

Recently, several plans have evolved designed as a first step to provide a so-called "unity organization" for the entire engineering profession. Almost all of the plans involve Engineers' Joint Council, Engineers' Council for Professional Development, and National Society for Professional Engineers in some way or other. Hence our committee is presenting to our membership a resume of the recent activities of the two umbrella organizations and of NSPE. More detailed information on any of these organizations may be obtained from annual reports published by the organizations.

Following the resume of activities of the three organizations there is a brief analysis of some of the unresolved problems facing AIME so far as any practical participation in the much publicized functional plan is concerned. This plan was described in the previous report by the committee.

ACTIVITIES OF ECPD

The activities of the Engineers' Council for Professional Development are carried out through the medium of national committees on Guidance, Education and Accreditation, Student Development, Development of Young Engineers, Recognition, Ethics, and Information. One or more of the Societies of AIME is represented on each of these committees. Activities of unusual significance include:

1) Guidance

With the appointment this year of chairmen for Alaska and Hawaii, the network of ECPD guidance committees now extends over all 50 states, the District of Columbia and Canada. It is within these committees that the effective work of guidance is accomplished through personal contact with students, counselors, teachers, and parents.

The guidance activity of the State committees was supported by the National Committee through a variety of programs. In providing this support, the committee followed the general policy that engineering should be presented as a good career for the qualified with no special emphasis placed on particular branches of engineering, particular schools of engineering, or particular employers of engineers.

Two mailings were made to the nation's 30,000 high schools. The first went in November to school superintendents and principals. It included the "After High School What?" folder, a letter of transmittal explaining the guidance program, and a form for requesting speakers and other counseling assistance from the State chairmen. In February, the counselors of these schools were sent a similar mailing and the current lists of ECPD accredited curricula in engineering colleges and technical institutes. These mailings ensured that administrators in practically all public, private, and parochial high schools were informed regarding the ECPD guidance services available to them.

2) Education and Accreditation

Engineering education today is dynamic. The increasing emphasis on science, greater depth in engineering analysis, new approaches to synthesis and design, rapid growth in graduate study and in research, curricula in new technologies—all are evidence of the transition and evolution occurring in engineering education. Some current educational innovations are bold, imaginative, and experimental. Other changes are more conservative and evolutionary in character. No curriculum is static and all curricula reflect in one way or another the implicit rising demands of our expanding technology. Enrollment trends in engineering, science, and mathematics also are having direct effect on curriculum planning and development in engineering. Increased importance of graduate study in engineering is prompting serious evaluation of the undergraduate curricula as preparation for advanced study. And,

* "New Plan for Unity" MINING ENGINEERING, October 1960, pp. 1080-1082.

FOR INTER-ENGINEERING SOCIETY COOPERATION

Committee: DOUGLAS RAGLAND; R. M. MAHONEY; WILL MITCHELL, JR., CHAIRMAN

beyond this current position is the growing interest in the concept of "professional engineering education," in the sense of medical and legal education, taught in a professional school following basic education in science, mathematics, the liberal arts, and fundamental engineering science.

To all such changes ECPD must be responsive, sympathetic, and encouraging. The Education and Accreditation Committee in this evaluation of curricula has followed the general guide lines of the ASEE 1955 Report on Evaluation of Engineering Education which were subsequently endorsed in principle by ECPD. At the same time, the committee has recognized the fact that no static standards or criteria for engineering education should exist and that curricula should be matched against rising standards of professional accomplishment and objectives. Consequently, the committee working within the general framework of the published "Basis for Accrediting of Engineering Curricula" and the "Additional Criteria" expects to see each school effecting continuing improvement through self-evaluation of curricula and objectives.

Graduate work in engineering is increasing rapidly and with it come problems of concern to the Education and Accreditation Committee. Pressure for accreditation of graduate programs continues to mount. Soon the present policy of accrediting "first degrees," whether carrying the B.S. or M.S. designation in a specified curriculum, will be inadequate to meet the issues raised by schools, professional societies, and industrial sponsors of part-time graduate study programs. For the purpose of assessing the problem, and recommending policy for E. & A. Committee consideration, and later for approval and action by ECPD, an ad hoc study group was established consisting of present members of the E. & A Committee or recent alumni.

Authorized by Council in 1958, the E. & A. Committee has had representatives of the Societies comprising ECPD and including the three Societies of AIME attend its meetings as observers. The representatives are the several Education Committee chairmen or their designees. Comments of the observers have been helpful to the E. & A. Committee.

Committee to Investigate Inter-Engineering Society Cooperation

The AIME Committee for Inter-Engineering Society Cooperation was appointed in February 1960 as an information-gathering group, to report its findings to the Board. As the preliminary study progressed, each member of the three-man committee was assigned to cover the activities of a society or group of societies touching the professional lives of AIME members. Will Mitchell, Jr., of the Society of Mining Engineers covered the activities of the National Society of Professional Engineers; Robert M. Mahoney of The Metallurgical Society was assigned to study the scope and organization of the Engineers Joint Council and the National Council of State Boards of Engineering Examiners; and Douglas Ragland, Society of Petroleum Engineers, covered the activities of the Engineers Council for Professional Development.

In turn the reports which the observers return to their Societies on the policies, procedures and efforts of the E. & A. Committee are useful in improved understanding of the committee's work and problems. The observers necessarily maintain the same discretion and hold the same confidence concerning committee discussions and recommendation as binds the regular members of the committee.

3) Student Development

This committee is continuing work on a brochure for use by students in the early years of their engineering education. It is the feeling of the committee that the earliest possible start should be made with students in colleges of engineering toward inculcating in these students the ideals of professionalism and in dispelling to the maximum possible extent the "sophomorish" casual attitude which too frequently exists.

Obviously, the wording and presentation in such a brochure is critical. It is recognized that the "Professional Guide for Young Engineers," now published by ECPD, is excellent for students at the senior or postgraduate level, but is quite inappropriate for underclassmen.

The three Societies of AIME are taking an increasingly significant part in all the activities of ECPD. The Boards of Directors and the Education Committees of the three Societies as well as the Board and the Council of Education of AIME are giving more consideration to the selection and the appointment of representatives to serve on the ECPD committees.

ACTIVITIES OF EJC

The Engineers' Joint Council advises on and coordinates matters of mutual interest to its constituent societies; it represents its constituents when joint efforts seem desirable; and it administers activities authorized by a majority of the constituent societies.

A Board of Directors, made up of representatives of the constituent societies and in numbers proportional to their membership, manage the Council. EJC, being a federation, the financing is by dues paid by the member societies. Membership in EJC includes ten constituent societies. However, provision is made for non-voting memberships of national and regional engineering groups as national associates and regional associates. At the present time there are three national associates and eight regional associates. Membership classification, as well as voting privileges, depend upon the size of the individual society and the provision that the majority of the membership of the group be engineers. AIME along with the other four Founder Societies are constituent members of the EJC. AIME now has three members on the Board of Directors of the Council which now numbers 29. There is an Executive Committee, which meets between council meetings, on which AIME also has a representative.

The objectives of the Council are published in the constitution and are not detailed here. However, they include the promotion of cooperation among the various branches of engineering, and the development of recommendations regarding public service policies respecting national and international affairs in areas where the application of the art and science of engineering will contribute to the general welfare of mankind. The Council endeavors to secure more efficient utilization of the scientific and technical potentialities of the art and science of engineering and of engineers, so that they may better serve the welfare of the nation during times of peace and for defense of the nation in time of war.

The objectives are implemented by such committees as Engineering Information Services, The Engineering Manpower Commission, Engineers' Research Committee, Information Processing Committee, International Relations Committee, Technical Planning Committee, National Transportation Policy Panel and National Water Policy Panel. During 1960 the Council instituted a quarterly publication, the "Engineer", so that the objectives and activities of the Council could be portrayed in more detail than had been previously possible. Each member of AIME receives a copy of "Engineer".

During the year EJC has participated with ECPD in an effort to provide a broad "survey of the engineering profession." It has established a liaison with the Engineering and Industrial Research Division of the National Research Council of the National Academy of Sciences. It has continued its study with the American Institute of Architects on interrelationships of architects and engineers, and acted as a coordinator of the April 1960 Nuclear Congress. It is cooperating with the Engineering Foundation in considering the possibility of establishing a national academy of engineers and it participates in the activities of the American Association for the Advancement of Science, and maintains official participation with the United Nations Educational. Scientific and Cultural organization.

There is another area of EJC activity. During 1960 the National Science Foundation made financial grants to Engineers Joint Council to help carry out certain activities of mutual interest. These grants, in combination with the personal and business time and ability contributed by the delegates and committee members and their organizations, made possible the following:

1) The maintenance of a listing of about 18,000 engineers in a position to locate individuals of special technical competence as required by the national defense effort.
2) A study of the merits of attempting to maintain a continuing and comprehensive National Register of Engineers.
3) A study of the subject of Polytechnic Dictionaries.
4) A study by a six-man delegation in the Union of Soviet Socialistic Republics of the utilization of engineers and engineering technicians.
5) Participation by an eight-man delegation at Buenos Aires, Argentina, in the Pan American Conference on Engineering Education and at the September 1960 meeting of the Pan American Federation of Engineering Societies (UPADI) in which Engineers Joint Council is the official United States representative.
7) Sponsorship of five visiting engineering lecturers from Europe for presentations at various United States educational institutions.

ACTIVITIES OF NSPE

NSPE dedicates itself to the promotion of the profession of engineering as a social, ethical and economic influence vital to the affairs of men and the United States. Its objectives are accomplished through the society's programs on local chapter, state society, and national levels. The Society holds that every engineer has two total areas of interest, one technical and one professional, the professional interests being common to all engineers rather than to the interest of any sectional group. One objective of the Society is to offer a vehicle to stimulate engineering leadership in public service activities. Another is to provide the opportunity to assist young engineers in meeting professional problems. The Society aims to establish standards of professional conduct for the protection of the public and the profession and offers the opportunity for personal participation of the engineer in a comprehensive program for the advancement of professional ideals and concepts.

The membership in NSPE is made up solely of engineers registered in any one or several of the States. The national organization is governed by a Board of Directors made up of representatives from each of the 50 states in proportion to the number of

registered engineers in the given state. The objectives of NSPE are implemented by national committees such as Employment Practices, Engineers in Industry, Ethical Practices, a Functional Section for Engineers in Government Practice. Functional Section of Consulting Engineers in Private Practice, Functional Section for Engineers in the Armed Services. NSPE has an Inter-Society Relations Committee, a Committee of Engineering Technicians and on Engineering Preparation, as well as several other committees concerned with the administration of such an organization as it is. The Society recommends that each of its members joins and supports the work of the technical society which serves his particular field of practice and, according to a recent survey made of the membership, three out of four members of NSPE are members of one or more of the technical societies with more than half of them being members of the Founder Societies.

NSPE maintains committees and paid staffs at national and state levels. Among other activities it watches closely all proposed legislation in which engineers are interested; it publishes information concerning these legislative matters to its members and it makes its views known to the appropriate committees in Congress and in the state legislatures.

AIME AND THE FUNCTIONAL PLAN

Very briefly stated, in the functional plan as suggested by the AIEE the many technical educational and professional activities of the Engineering profession would be the responsibility of EJC, ECPD and NSPE. EJC would coordinate the universal technical activities of the technical societies; ECPD would coordinate the educational activities for the profession and the NSPE would have the responsibility of coordinating the professional aspects including legislative matters affecting the profession.

As reported previously, AIME is a constituent society of EJC and ECPD and contributes its share of the financial responsibilities of the operation; whereas NSPE is made up of individual dues paying members. AIME as an Institute could not be a member of NSPE and members of AIME can belong to NSPE only by applying for membership in this completely separate and independent organization which requires that applicants be registered as professional engineers in one or more states. From a most recent estimate, approximately only 1500 AIME members out of a total of our 36,000, are members of NSPE.

It is obvious that EJC and ECPD adequately represent AIME in their areas of operation. However it is also obvious that NSPE is not in a position at the present time to represent AIME in one important segment of the functional plan. It is realized that there may be many AIME members who are registered engineers in the various states who are not members of the National Society of Professional Engineers. However, by no reasonable extrapolation can NSPE today be considered as representing the professional interests of our metallurgical, geological, mining and petroleum engineers. The committee realizes there are many valid reasons why more of our members have not become members of NSPE. As stated previously, NSPE requires that all of its members be registered engineers in at least one of the 50 states. However, we realize in past years that legislation on registration of engineers was often written into the laws of the various states through the efforts of consulting engineers in the field of civil engineering. Naturally the examinations that were set up in these states were oriented to the discipline of civil engineering. More recently, mechanical engineers and electrical engineers have prevailed upon the State registration boards to establish examinations suitable for their respective disciplines. At the present time, there are many states that do not have examinations suitable to the training of the engineers in the mining, metallurgical and petroleum industry. The same situation holds for the chemical engineering discipline, sanitary engineering, radio engineering, etc. In fact, the laws have not kept pace with the advance of technology, making no provision, to cite examples, for fields involving earth structures important in dam and tunnel construction, radioactive waste disposal, smog control, and other problems of smoke abatement, all of which are directly in the field of public health and welfare.

Because of the nature of our profession in the mineral industry, the members of AIME in general are professional salaried employes on the technical and management staffs in mining, metallurgical and petroleum corporations. A relatively small proportion of our people are in consulting practice. However, those who are so engaged are concerned in the requirements of registration very keenly and many are handicapped by the difficulty of becoming registered in their fields of competence. It is for the benefit of those members who now or in the future may be so engaged in consulting work involving public health and welfare that AIME should concern itself with the problems of licensing and registration and with the examinations which our members must take to qualify.

At a recent AIME board meeting, President Gillson and the committee were authorized to make a survey of the 50 states in order to determine in which states our members could or could not be registered. In a preliminary analysis, the committee found that there are 14 states in which AIME has representatives on state registration boards of professional engineers. It is presumed that in most of these states suitable examinations should be available for our people. In the meantime, representatives of the National Council of State Boards of Engineering Examiners have offered to cooperate with AIME in its efforts and the NSPE Board of Directors at their last meeting in Denver voted to cooperate with AIME in attempting to establish suitable examinations for AIME members in those states where such examinations do not exist.

Until this survey is completed, the AIME committee on Inter-Engineering Society Cooperation feels that it is not in a position to make any recommendations on this particular subject.

It has been encouraging to the committee to note that several of the larger technical societies have joined in suggesting to NSPE that the membership requirements of the National Society be relaxed to permit the acceptance of engineers of eminence and experience into NSPE without examination for a reasonable period of time. Should NSPE open its membership to engineers of eminence and experience regardless of whether they are registered professional engineers, then a substantial number of members of AIME may join NSPE and help guide the activities of that organization in professional fields so that it then can be of service to engineers in mining, metallurgical, and petroleum engineering.

CONTRACT PAY SYSTEM AT BUTTE

by V. D. O'LEARY

Contracts between The Anaconda Co. and its miners at Butte, Mont., are not contracts in the true sense of the word. They are weekly verbal agreements which tacitly admit that the company, on the one hand, will supply the place, the tools, the material, and the opportunity and that the miners, on the other hand, will supply such effective labor that both parties will profit from the arrangement.

Prices are seldom discussed at the time of hiring. The miner, in effect, is hired for a definite working place, as a contract miner, and if satisfied, tries to earn as much as he can. If he is not satisfied three courses are open to him: he can quit, he can ask for a change, or he can discuss prices or improved working conditions with the mine superintendent. This rather informal arrangement is due to conditions that are particular to Butte.

No two mines in the district are alike in their physical characteristics. Temperatures in working places run from a low 55° to a high of 90°, ground ranges from soft to very hard, width of ore varies tremendously, and stability of ground runs the gamut from excellent to very bad.

Before the contract system was initiated in Butte 35 years ago, all the mines were underground vein mines. Ore was extracted from numerous small openings, in each of which was a two-man team. Some of these miners were very industrious and developed remarkable skills, often accomplishing a far greater amount of useful production than the less energetic workers.

Naturally a demand was created for this type of worker, and soon concessions of one type or another were being offered to the *highballer*, as he came to be known. It became evident that some equitable means must be devised, not only to reward the industrious worker, but also to offer incentive to others who, while they might not approach the status of *highballer*, would still accomplish more than an average day's work.

At the same time, the method devised would have to be so flexible that the widely different mines, faced as they were with the same labor pool, would be able to compete equally for high-class labor.

Today the contract system—even though it has been refined and adjusted through the years to meet ever-changing economic demands—still gives the miner a feeling of independence and the right to bargain his labor against company prices. The company, on the other hand, has been able to introduce advanced methods and improved equipment into the contract system without discarding its guiding principle—that both miner and company shall profit from the arrangement.

V. D. O'LEARY is Assistant General Superintendent of Mines, The Anaconda Co., Butte, Montana.

THE CONTRACT METHOD

Basically the contract specifies that the miner will be paid a unit price for any and all types of work done in connection with the production of broken rock. Generally, he fulfills his part of the bargain when the rock is in the chutes, or in cars ready for transportation. The principal unit for measurement is the cubic foot, but linear advance is paid for in sills, raises, and shafts.

Working places are carefully mapped and measured weekly by engineers, who speed and simplify the gathering of contract data by using sketch paper cross-hatched in two forms. The first, called the *plan section*, is used in areas best visualized by a top view. Each square in this form represents a standard timber set. The second, called the *raise section*, is used in areas best visualized by a side view. Each rectangle in this form also represents a standard timber set, but shows the elevation instead of the width and depth dimensions of the standard square set.

The difference between the previous week's measurement and the new one is the amount of work performed during the week. Excavation, timbering, and rock shipped are calculated on regular contract forms. Various other items, called *miscellaneous*, which are part of the upkeep of the working place, are added to the contract. These miscellaneous items are standard and are priced the same in all mines. Examples of miscellaneous work are rock bolts, chute lining, stulls, and curved track.

After the cubic foot measurements or linear foot advances have been calculated they are multiplied by the individual unit prices for that particular contract and are added up, together with the miscellaneous earnings, to determine the total amount of contract earnings. This total amount is divided by the number of manshifts charged against the con-

Jumbo drilling in a sill at Butte. Extent of linear advance and type of equipment used determine miners' earnings.

tract in that week, and the resultant figure is the contract rate for the contract during that week.

PROCESSING OF MINERS' COMPLAINTS

On the same day the contracts are calculated, they are typed on long sheets in progressive order according to contract number and posted on the mine bulletin board so the miners may examine them. The contract rate is the focal point of attention, and most miners have an accurate idea regarding the amount of money they have earned during the week. If the contract rate is unsatisfactory to them, they scan the individual items and prices to see if something has been overlooked or a wrong price used.

Any individual miner who feels that a mistake has been made in his contract, regardless of whether it is in measurement or calculation, can register a complaint. His complaint is duly recorded and on the following day a disinterested engineer is assigned the task of investigation. This involves a thorough checking of measurements underground, calculations, and prices.

The result of the investigation is also recorded, and the miner is contacted, usually by his shift boss, and informed of the outcome of his complaint. If he has been underpaid, he will be paid the amount due him the following week by separate check. Conversely, if he has been overpaid, the amount is subtracted from his check the following week. A miner who is still unconvinced that the measurement is right may turn his complaint into a grievance and have it taken up through the regular grievance procedure.

No contract is paid off at less than the prevailing base wage. The earned rate, even if below a "day's pay," is posted on the bulletin board. Anything over the base rate is considered "contract earnings." Contracts that fail to earn the base rate are called "under day's pay contracts," and the difference in total money between the base rate and the contract rate is called "unearned money."

ADJUSTMENT AND CONTROL OF CONTRACT PRICES

Changes in contract prices due to an increase in the prevailing base rate is accomplished by a percentage method. The average contract rate is determined for the period under the existing base rate. Shift differentials, overtime, and holiday pay increments per shift are subtracted from this average contract rate. What actually remains is the average contract rate minus all fringe benefits. The raise *per day* is then divided by the average contract rate minus fringe benefits to get a percentage figure. This figure plus 100 pct is the factor used in multiplying existing contract prices to get the new contract prices under the new base rate.

The mine superintendent is wholly responsible for contract unit prices. He works within limits based on the type and character of ground and working conditions, but he has considerable latitude between those limits. His basic problem is to make low contract costs and still keep from underpricing his mine in labor competition. He has authority to attack special problems in the manner he sees best, but he must be able to offer valid reasons for doing so. He is a ruling force in forming contract policy, but he must abide by the rules so formed.

CONTRACTS AND WAGE COMPUTATIONS ADAPTED TO WORKING CONDITIONS

Stoping: Excavation prices are set in a schedule of five classes, each providing a different compensation for conditions that may be encountered. The base price of the particular class set for a working place is the one posted on the contract forms. This base price is constant for ore widths from 7½ ft up, but it increases for the first one-half foot decrease in width and for every foot decrease thereafter. The money paid for an amount of work done at a lesser width is greater than that paid at the base width. For example:

A 5-ft round, 8 ft high and 7½ ft wide, breaks 300 cu ft of ground. In Class I the base price is \$0.03 per cu ft; thus, $0.03 \times 300 = \$9.00$ contract earnings.

A 5-ft round, 8 ft high and 6 ft wide, breaks 240 cu ft of ground. The price on the graduated scale in Class I is \$0.045 for a 6-ft width; thus, $0.045 \times 240 = \$10.80$ contract earnings.

A 5-ft round, 8 ft high and 3 ft wide, breaks 120 cu ft of ground. From the graduated scale in Class I the price for a 3-ft width is \$0.083; $0.083 \times 120 = \$9.96$ contract earnings.

Thus the miner is not discouraged when confronted with a narrowing ore face, but in fact is actually encouraged to break clean ore. He loses nothing by doing a conscientious job.

Timber is measured in terms of cubic feet installed. The volume of space occupied by the timbered set is the amount of cubic feet in that set.

Most stope sets are standard, so that measuring them is routine work. They have three general classifications: 4-post lead, lead, and corner. The cubic-foot equivalent of these classifications, and other less common types of timber support, is posted on price charts for the convenience of engineers when calculating contracts.

This timber price is the same for all stopes and all mines, since once the ground is removed it should be no more difficult to stand timber in one place than in another. An increment price increase is allowed, however, for unusual cutting or framing. For example, 1569 cu ft of timber were installed in a working place. Three corner sets, or 660 cu ft, were framed to fit the footwall ground. The standard stope timber price is $0.029 per cu ft. An increment rise of $0.004 per cu ft is allowed for framing.

Thus: $909 \times 0.029 = \$26.36$
$660 \times 0.033 = \$21.78$

Contract earnings for timber $= \$48.14$

Had no framing been necessary the contract earning for timber would have been:

$$0.029 \times 1569 = \$45.50$$

Thus the miner received $2.64 for his framing operation.

Mucking prices vary according to the method used and the size of equipment. There is very little scraping or hand mucking, however, since 85 to 90 pct of all mucking is mechanized, and most of the rest is gravity-activated. Men operating 30-hp to 50-hp slushers and large scrapers command $0.025 per cu ft of stope slushing. Those working with slushers of lesser horsepower and with smaller scrapers are paid 0.5¢ higher per cu ft.

Sills: Excavation in horizontal headings is paid per linear foot of advance. Sills are listed under two categories: timbered and untimbered. Timbered sills have three classes, and untimbered sills have four. Premium prices per cubic foot are paid for sills of smaller cross section, as shown in the following table:

Section	Cross Section, Sq Ft	Linear Advance, $	Excavation, Cu Ft, Equivalent Price, $
7 × 5	35	4.40	0.126
8 × 6	48	4.75	0.099
9 × 7	63	5.40	0.086
10 × 9	90	6.60	0.073

Again, the various classes are used to compensate for unusual conditions.

Timber prices are standard for all headings and are paid for cubic feet of timber installed, but the price per set may not be the same since the cubic feet per set varies with the size of the sill.

The sill-shoveling price is controlled by the size of equipment used. The smaller the equipment, the greater the price. A miner using equipment of lesser capacity and therefore working at a disadvantage can make more money than a miner using equipment of greater capacity, provided he loads out the same volume. As an example, for one miner using a B-21 Eimco loader and 115-cu ft Granby car:

$115 \times \$0.028$ per cu ft $= \$3.22$ contract earnings

For another miner using a B-12 Eimco loader and a 57-cu ft Granby car:

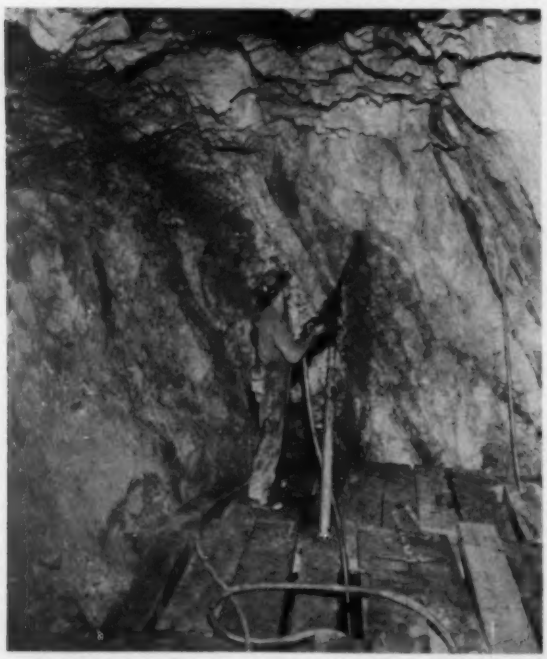
$57 \times \$0.038$ per cu ft $= \$2.17$
$115 \div 57 = 2.02$
$2.02 \times \$2.17 = \$4.38$ contract earnings

Raises: Raises are generally either 13x7½ ft or 18x7½ ft in dimension, and there are four classes in each size. Prices are based on linear feet of advance since this, rather than production, is the main objective. In either size the ore may become less than 7½ ft in width, but the advance price remains the same, thus encouraging the miner to break clean ore with less drilling effort. If it is necessary to break a width greater than 7½ ft, the miner is paid at an enlarging price per cubic foot for the ground in excess of the standard cross section. Each class has its own enlarging price.

Timber prices are standard at so much per cubic foot. However, where ground is bad enough to warrant using timber of less than normal length, $0.004 per cu ft is added to the standard price to compensate for the extra effort required for working in restricted space. The $0.004 increment paid in stopes for hand-framed timber is similarly paid in raises.

Shafts and Winzes: Contract procedure in shafts and winzes is very similar to that in raises. However, the sinking of shafts and winzes is rare enough to preclude the necessity of a standard price schedule. Prices are dependent on peculiarities of the individual place. Contract measurements, including mucking, are in linear feet. An exception to this occurs when chance changes the cross section. For example, sloughing might enlarge the cross section from 14x6 ft to 14x8 ft. The difference in cubic feet would be 28 cu ft per foot of advance. This difference would be paid for at a cubic-foot price.

Block Caving: The Kelley mine, which is a block-caving operation, abides by the same principles followed by the other mines in making contracts. Haulageways, service ways, and ventilation drifts are placed on class schedules as in those other mines. There is a separate three-class schedule for those



Drilling an ore face in a stoping operation at Butte.

The wages a miner receives for setting timber in sills (such as shown above) is determined by the sill dimension.

openings which are peculiar to the Kelley in size, but most fringe drifts and crosscuts follow the regular mines schedule. If there is a difference in a Kelley contract, it lies only in the amount and kind of miscellaneous work.

In preparing a block for extraction, all the men work on a single contract. While one group drives fringes, ventilation crosscuts, or slusher drifts, another group may be installing forms, placing concrete, or railing slusher drift bottoms. Each miscellaneous item has a fixed standard price and is added to the contract just as is done in the other mines.

This multi-crew contract is very satisfactory to the miners and is invaluable to management in that it gives comprehensive cost data and a quick general view of preparation progress.

CONCLUSION

It may now be asked: How were the contract prices originally determined? The answer lies in the background created by the many years of experience that a host of operators and engineers have gained in their daily work on underground problems. In the beginning, conferences between these men determined a normal shift's work for one man under varying conditions. As the years passed compensations were made for the vast improvements in equipment and mining methods. Contract prices were raised as base wages were raised, but price schedules were adjusted as the manual work became lighter and the production potential was increased.

How accurate and how fair is the Butte contract system? In a recent ten-year study covering 245,515 contracts, there were 5007 contracts adjusted. This amount represents 2.04 pct of the total. 3926 of the 5007 adjusted contracts were the result of miners' complaints; the other 1081 adjusted contracts were made by the engineering staff when checking calculations and sketches, and thus were not the result of any complaint.

The Anaconda Co. has made every effort to be impartial in measuring and calculating contracts. The operating staff cannot adjust a measurement or change a calculation; the engineering staff assumes the professional attitude of a referee between company and contractor. The operating staff does control prices and can change them upward for good reasons, but it cannot downgrade them without first giving the miners involved a week's notice.

The inherent fairness of the contract system has made a deep impression on contractors. This is attested by the fact that in one 122-month period only four contracts, out of 197,743 in force, were processed by grievance machinery. This is about 2/1000 of 1 pct.

In an era when management is facing united opposition by labor against the use of more efficient methods, programs such as the Butte contract system are invaluable. They can remain so only as long as management retains full control of the incentive program. Labor's attempt to regiment the workers has been all too successful. Industry's answer lies in the proven operation of incentive systems which demonstrate to the workers that they have more to gain by individual effort than by conforming to a robot standard.

FIGHTING FIRE WITH FOAM AT MONTOUR NO. 4 MINE

by C. WILLIAM PARISI

Use of high-expansion foam for controlling mine fires was first made known in a published announcement in June, 1956, by representatives of the Safety in Mines Research Establishment, Buxton, England. In 1957, the United States Bureau of Mines, interested in this new method of controlling mine fires which could not be approached or extinguished by conventional methods, began to investigate the practicability of the foam-plug technique under American mining conditions at its experimental coal mine in Bruceton, Pa.

Results of these experiments proved the potentialities of controlling mine fires with foam. The USBM conducted numerous demonstrations at its experimental mine to show this foam-plug method to groups of coal mining men, many of which were impressed by the action of the foam as it moved away from the netting toward an open fire and its ability to control the fire in a very short time.

The Pittsburgh Coal Co. became interested in this new method of controlling mine fires, and when Safety Development Corp. developed a package unit, the Company obtained one to conduct tests at a mine site. These tests were so impressive that arrangements were made to purchase a unit as an addition to the present fire-fighting equipment. To the company, it represented another way of delivering water to a fire when conventional methods failed.

The foam unit was sent to the Montour No. 4 mine in Lawrence Co., Pa., a highly-mechanized underground operation which produces 5300 tpd of coal from the volatile, 60-in. thick Pittsburgh seam. This coal bed is overlain by a draw slate above which are laminations of coal and shale. When a fire occurs in the Pittsburgh seam, this overlying coal will also begin to burn within a short time. The roof falls which eventually result from this weakening of the overhead strata adds to the difficulty of extinguishing any fire in the main seam by covering the burning material with large quantities of debris.

In addition to the foam generator, equipment available for fighting fires in this mine consists of water lines and five portable fire cars located strategically throughout the mine. Three cars have a capacity of 2100-gal each and two are of 900-gal capacity. Each car is equipped with a 2-in. hose, a combination fog and straight nozzle, and a pump capable of discharging approximately 100 gpm at 100-lb pressure measured at the end of a 600-ft hose.

Other water lines are extended throughout the mine to supply spray water for fire-fighting in each coal-producing section. During the fire, some of these 2-in. hoses were brought into play against the fire, and when required, were also used to refill the fire cars. Two high-pressure pumps are employed to supply water from a well and from the city water supply.

FIRE SPREADS AS SMOKE, GAS DELAY FIGHTERS

Between 11:30 and 11:40 AM on June 10, 1960, a fire of undetermined origin began near an automatic car spotter located close to the discharge end of a coal conveyor belt. This location was in a so-called "neutral" air zone; that is, only enough air was permitted to course through the area to keep it free from gas accumulations. There were nine men in the coal-producing section near the fire, and the first concern was for their safety. While the foreman of the crew was making preparations to evacuate them by way of an adjacent section, arrangements were made to remove all other workmen from the mine and to have the fire cars transferred to the fire area.

The first fire car arrived about 30 min after the first alarm. By that time the smoke had moved back along the intake entries in sufficient quantity to prevent immediate application of water directly on the fire. An effort to move this smoke by increasing the quantity of air traveling over the fire was made by opening a man-door in a stopping which separated the intake from the return, and also by partly removing another stopping. This action was partially effective but it consumed valuable time.

The same result could have been more quickly obtained had it been possible to open the air lock doors located near the fire. However, with workmen in this location, it was not deemed advisable to do this until the men were out of the face area. When it was assured that these workers were evacuated, rescue men were dispatched to open these doors to increase the volume of air.

Approximately two hours had elapsed from the time the fire was discovered until the air lock doors were opened. During this time the fire fighters were attempting to approach the fire by using a fog nozzle to push back the smoke and by erecting canvas checks to direct all the air into one entry. The two hours which had elapsed, however, was sufficient

C. W. PARISI is Director of Safety of Pittsburgh Coal Co., Library, Pa.

for the fire to grow in its intensity and to spread. The heat generated by the fire caused numerous roof falls which hampered the operation. In addition, the concentration of combustible gases returning from the fire zone began to increase.

When it became apparent that this method was ineffective in extinguishing the fire or preventing its spreading, it was decided to rush the foam generator unit into operation. The mine rescue men continued fighting the fire with water while the foam generator was being set up. At 9:00 PM, this unit was pressed into service.

FOAM GENERATOR AND HOSES COMBINE TO CONTROL FIRE

Canvas checks and wood stoppings were erected across the parallel intake entries in line with the foam generator to direct the foam toward the fire. While the foam plug moved to the fire zone, constant checks were made on the combustible gases returning from the area. Within a short time after starting the foam unit, the concentration of combustible gases began to drop.

Due to the continuing accumulation of such gases and the covering of fires by debris, it was necessary to alternate the use of the foam generator with the direct application of water to the fire. Periodically the foam unit was stopped, and the rescue men entered the fire area to spray water on burning material. Each time the concentration of combustible gases increased to the danger point, the men would be withdrawn and the foam unit restarted until the quantity of such gases had decreased to a safe limit.

The foam plug was able to extinguish the open fires, and equally important, cool the area sufficiently to permit fire-fighters to enter and apply water to the hot fires which were beneath heavy roof falls. On one occasion water from two fire hoses, each delivering about 100 gpm, was poured on a roof fall which had a deep-seated fire burning beneath it. The two hours futilely spent in attempting to extinguish this one fire permitted other fires, previously controlled by the foam plug, to rekindle and burn furiously. Direct fire fighting had to be stopped, and the foam generator placed back into operation.

During one of the periods the foam generator was stopped, it was discovered that the fire was spreading toward a mined-out area. The unit was moved to another location where the foam could be directed toward the endangered area, and within a short time, it was successful in stopping this threat to the mined-out section.

FIRE ZONE SEALED OFF

Intermittent use of the foam unit continued until 8:00 PM the following day (June 11), at which time a decision was reached to seal off the fire area. The foam had stopped the open fires, but it was unable to put out the hot burning material beneath the large roof falls. With the foam unit in operation, seals were erected between the fire area and the stoppings separating the intake from the return entries. This left one entry open between the fire seals and the row of stoppings to permit air travel around the outside of the seals.

As the sealing operations advanced toward the back side of the fire, the foam unit was stopped momentarily until temporary canvas checks were emplaced to minimize smoke around the workmen erecting the seals. Once each temporary check was in place, the unit was put back into operation until the permanent fire seal was erected to replace the canvas. By using the foam unit in this manner, it was possible to reduce the heat coming from the fire and also prevent the accumulation of high concentrations of combustible gases.

The fire area was completely sealed and all men out of the mine at 2:45 AM, June 14, an elapsed time of 87 hours from the discovery of the fire until the completion of the seals. The foam unit was in operation intermittently for approximately 60 hours. More than 80 barrels, or 4400 gal, of foaming agent and an estimated 500,000 gal of water were used to bring the fire under control. Thirty fire seals and 40 dry stoppings were erected or repaired to confine the fire.

SUMMARY

In analyzing the performance of the high-expansion foam plug on this particular fire, the following conclusions were reached:

1) Erection of the foam unit can be accomplished in a relatively short time, and it can be moved quickly to other locations during the fighting of a fire as conditions may require.

2) The percentage of combustible gases coming from a fire is less when using the foam unit than when fighting the fire directly with water.

3) The foam plug played a very definite part in preventing the fire from spreading. Had it not been for the foam plug, it is believed that the fire would have spread over into the mined-out area, thereby endangering a large portion of the mine. The man door in a stopping was burned but the fire did not spread into the old workings.

4) There is some question as to its effectiveness on deep-seated fires under heavy falls.

5) A supply of foaming agent can be depleted in a very short time. Approximately three barrels of foaming agent are consumed by the generator for each hour of continuous use.

6) An ample supply of water is required when using the foam unit. The unit required approximately 85 gpm of water.

7) The foam plug enabled the fire seals to be erected so as to seal off a relatively small area for the type and intensity of the fire.

8) Air samples, taken as the final seals were completed, showed the following pct analysis:

	Seal No. 5 Pct	Seal No. 10 Pct	Seal No. 29 Pct
CO_2	8.2	9.0	2.01
O_2	8.0	5.1	17.71
H_2	0.9	1.3	0.37
CO	1.5	2.2	0.50
CH_4	4.9	6.0	0.84
N_2	76.5	76.4	78.57

The fire seals were opened on December 8, 1960, and exploration of the area within the seals indicated that the fires had not spread from where their last location was observed prior to the sealing operation. The roof falls were massive in the locations of intense burning, namely, the discharge end of the conveyor belt, the car spotter, the belt drive, and along the empty track entry leading to the loading head. The exploration also revealed that numerous wood posts set for roof protection during the direct fire fighting, were not marked in any way to indicate any further burning in that area from the time they were emplaced.

The foam generator should not be considered a cure-all nor should it be a "last resort method" of controlling mine fires. It is, however, an important addition to other conventional fire-fighting equipment.

Let's All Meet at the Stardust!

A.I.M.E. Southwest Mineral Industry Conference with Industrial Minerals Division, S.M.E.

Las Vegas, April 24-25, 1961

EVENTS:

Sunday, April 23, 1961

Registration (Men)	2:00 p.m.
Registration (Women)	2:00 p.m.

Monday, April 24, 1961

Speakers Breakfast	7:30 a.m.
Registration	8:30 a.m.
Ladies Registration	8:30 a.m.
Ladies Hospitality	9:00 a.m.
All Participants Session	9:30 a.m.
All Participants Luncheon	12:15 p.m.
Ladies Luncheon	12:30 p.m.
Industrial Minerals Session	2:30 p.m.
Extractive Metallurgy Session	2:30 p.m.
Nuclear Progress Session	2:30 p.m.

Monday (Continued)

Geology Session	2:30 p.m.
Cocktail Party	5:00 p.m.
Dinner Show	7:00 p.m.

Tuesday, April 25, 1961

Speakers Breakfast	7:00 a.m.
Industrial Minerals Breakfast	7:00 a.m.
Registration	8:30 a.m.
Ladies Hospitality	9:00 a.m.
Industrial Minerals Session	9:00 a.m.
Nuclear Progress Session	9:00 a.m.
Geology Session	9:00 a.m.
All Participants Luncheon	12:15 p.m.
Industrial Minerals Session	2:00 p.m.
Physical Metallurgical Session	2:00 p.m.
Mining Session	2:00 p.m.

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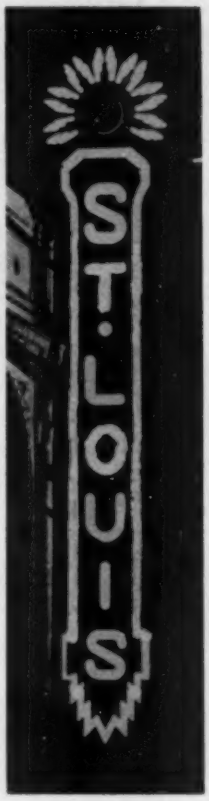


More Annual Meeting News

Field Trips Featured at 90th Annual Meeting

In addition to the River King mine trip listed in the program which appeared in the December issue of MINING ENGINEERING, three field trips have been planned for Thursday, March 2. Trips to the following firms will be offered: Mallinckrodt Chemical Co., Weldon Springs, Mo., where visitors can see the processing of uranium ores and reduction to metal; Viburnum mine of St. Joseph Lead Co., Viburnum, Mo., where a new orebody discovered in the area resulted in construction of a modern 3000-tpd mill; and one of Shell Oil Co.'s largest refineries at Roxana, Ill.

Mining Geology Symposium

Of more than usual interest to mining operators and management men, this Wednesday morning symposium, Khorassan C Room, will cover practical aspects of mining geology. Further details on page 198.

Abstracts

Late abstracts not published in the December issue will appear in a special section (pp. 12-14) in the SME Abstract Booklet to be distributed at the Annual Meeting.

SME News of Special Interest in This Issue

From the Four Corners of the Globe

International Experts on Agglomeration to Meet in Philadelphia

The Symposium on Agglomeration, sponsored by AIME, will be held April 12 to 14 at the Sheraton Hotel in Philadelphia. The conference will deal with sintering, pelletizing, nodulizing, briquetting, powder metallurgy, ceramic bonding, and related processes. Areas of application will include ferrous and nonferrous ores, carbonaceous materials, and ceramics and other nonmetallics. All of these phases of the subject will be covered by technical papers being written by specialists from all over the world.

During the six technical sessions, more than 30 papers from 11 countries will be presented in the form of abstracts. Preprints of these papers, with abstracts in English, French, and German, will be mailed to all pre-registrants on March 1, 1961.

Prepared discussions will be presented and, if time permits, spontaneous discussions. All technical papers accepted for the Symposium, together with discussions, will be published in a bound volume and will be mailed to all registrants promptly after the Symposium. Non-registrants who are AIME members will be able to secure copies of the Proceedings for about $20, nonmembers for about $25.

The official language of the Symposium and all functions will be in English. German and French interpreters will be available at all functions and sessions and will wear color bars indicating:

English—White
French—Blue
German—Red

arranged in various combinations. The non-English-speaking registrants who wish to present oral discussion during the session should present a written outline to the Language Co-ordinator at the Registration Desk at least one day in advance.

A special feature, designed to save time during the technical sessions, is the daily luncheon at which authors of papers will preside at specifically marked tables, giving each person an opportunity to sit with an author and discuss his paper.

Program

(As of January 25, 1961)

Technical Session 1—Wednesday, April 12, 1961—8:30 am to 12:00 noon.

Pelletizing Characteristics of Raw Mixes for Cement Manufacturing by J. R. Tonry, Portland Cement Assn.

Microstructure in Binderless Briquetting by O. G. Ingles, Commonwealth Scientific & Industrial Research Organization, Melbourne, Australia.

Compacting and Sintering of Metal Powders Without the Application of Pressure by H. H. Hausner, Consulting Engineer.

The Properties of Active Ceramic Oxide Powders in Relation to Sintering Behavior by P. Murray, United Kingdom Atomic Energy Authority, Harwell.

An Evaluation of the Properties of Dolomites Affecting Self-Fluxing Sinter Rates by R. A. Limons and H. M. Kraner, Bethlehem Steel Co.

Welcoming Luncheon—Wednesday, April 12, 1961—12:15 pm. AIME President R. R. McNaughton, speaker.

Technical Session 2—Wednesday, April 12, 1961—2:00 pm to 5:30 pm.

Tumbling Resistance and Reducibility Tests for Evaluating Nickel Silicate Ore Sinters by T. D. de Souza Santos, Institute de Pesquisas Technologicas, Sao Paulo, Brazil.

Properties of Sinter Smelted in the Electrothermic Zinc Furnace by D. E. Warnes, St. Joseph Lead Co.

Advances in Balling and Pelletizing by H. T. Stirling, Koppers Co.

Preparation of the Raw Material Charge in the Sintering of Lead Concentrates by D. Ingvoldstad and K. Kirkpatrick, The Bunker Hill Co.

Dynamics of Pelletization by U. N. Bhrany, R. T. Johnson, and T. L. Myron, U.S. Steel Corp.

Technical Session 3—Thursday, April 13, 1961—8:30 am to 12:00 noon.

The Sintering of Mixed Powders by J. White, University of Sheffield, England.

Characterization and Sintering of Powders by H. J. Oel, Max-Planck-Institut für Silikatforschung, Wurzburg, Neunerplatz, Germany.

The Oxidation Rates of Zinc Sulfide Spheres by G. S. G. Beveridge, University of Edinburgh and Heriot-Watt College, Glasglow.

Rate of Densification in the Sintering of Uncompacted Metal Powders by F. N. Rhines, R. T. DeHoff, and R. A. Rommel, University of Florida.

The Strength of Granules and Agglomerates by H. Rumpf, Lehrstuhl und Institut für Mechanische Verfahrenenstechnik, Karlsruhe, Germany.

Technical Session 4—Thursday, April 13, 1961—8:30 am to 12:00 noon.

Engineering Contributions to New Techniques of Iron Ore Agglomeration by M. J. Greaves and A. English, Arthur G. McKee & Co.

Conventional Hot Air and Mixed Fired Sintering by H. Rausch and F. Cappel, Lurgi, Frankfurt, Germany.

The Basis of Sinter Plant Design by R. F. Jennings and A. Grieve, Huntington, Heberlein & Co. Ltd., London.

The Continuous Sintering Process—Research and Applications by T. E. Ban, C. D. Thompson, D. C. Violetta, and C. A. Czako, McDowell Co. Inc.

Automation of the Sintering Machine by K. Wada and K. Tsujihata, Yawata Iron and Steel Co. Ltd., Japan.

Luncheon—Author's Table—Thursday, April 13, 1961—12:15 pm.

Technical Session 5—Thursday, April 13, 1961—2:00 pm to 5:30 pm.

Pressure and Water Gradients Through a Sinter Bed by R. Wild, British Iron & Steel Research Assn.

The Combustion Zone in the Iron Ore Sintering Process by R. Schluter and G. Bitsianes, University of Minnesota.

Heat Hardening of Artificial Magnetite Pellets by W. Callender, The Broken Hill Proprietary Co. Ltd., Australia.

(Continued on page 198)

Session Planned on Rock Mechanics

The Fourth Symposium on Rock Mechanics, jointly sponsored by the departments of mining at Colorado School of Mines, University of Minnesota, Missouri School of Mines and Metallurgy, and the Pennsylvania State University, will be held on March 30 and April 1 at Penn State. This is the first time that Missouri has been a participant in sponsoring the symposiums, which rotate among the schools on an annual basis.

The program will consist of four technical sessions treating the following subjects: behavior of rock under static loading; behavior of rock under dynamic loading; measurement of rock properties and stress instrumentation; and ground control and subsidence. While the emphasis will be on application to problems of mining technology and science, others, such as petroleum engineers, geologists, and geophysicists will find much of value in the program.

AIME Board Names Honorary Members

Three distinguished AIME members have been elected to Honorary Membership in the Institute for 1961. They are John Fairfield Thompson, Carl E. Reistle, Jr., and René Victor Marie Perrin.

John Fairfield Thompson

John Fairfield Thompson is honorary chairman of The International Nickel Co. of Canada Ltd. and The International Nickel Co., Inc. He joined International Nickel in 1906 as metallurgist to design and operate a research laboratory at the company's Orford works for the investigation of the potentialities of Monel nickel-copper alloy, which had just been developed. He later established and became manager of the company's first technical department, a forerunner of International Nickel's present Development and Research Div. In 1928 he was elected assistant to the president and in 1949 he became president, a position he

(Continued on page 203)

University of Arizona Offers Computer Course

The University of Arizona announces a short course on computers and computer applications for managerial and technical personnel in the minerals industry on the college campus in Tucson from April 4 through April 7. The course is designed to familiarize people in responsible positions in the industry with the relatively new and rapidly expanding field of high-speed data processing.

Sponsored jointly by the Department of Mining and Metallurgical Engineering and the Numerical Analysis Laboratory, the course will deal specifically with computers and peripheral equipment, introduction to computer programming, mathematical techniques, and feasibility of computer utilization.

The fee for the course is $100 per person and does not include food or lodging. Application for the course should be made by letter, giving the participant's name, company affiliation, and occupation, and enclosing the fee. Checks should be made payable to The University of Arizona. The application deadline is March 1. Direct all communications to:

Professor E. R. Drevdahl
College of Mines
The University of Arizona
Tucson, Ariz.

Willis Thompson to be New President of UET

Willis F. Thompson, executive vice president of Westcott & Mapes Inc. and a former Vice President of The American Society of Mechanical Engineers, has been elected President of United Engineering Trustees Inc. He succeeds Andrew Fletcher, who has held the post for the past two years. Mr. Fletcher has taken on Mr. Thompson's former post as Chairman of the UET Real Estate Committee.

UET also announced the election of two new Vice Presidents, James F. Fairman, representing the American Institute of Electrical Engineers, and L. C. Kemp, Jr., representing the American Institute of Chemical Engineers; and two new trustees, Michael L. Haider, representing AIME, and William H. Wisely representing the American Society of Civil Engineers.

United Engineering Trustees is the owner of the new United Engineering Center now under construction at United Nations Plaza. By January work had reached the stage where most of the exterior enclosure of glass, spandrelite, and limestone had been placed.

Dwight D. Eisenhower Awarded Hoover Medal

The Hoover Medal *for 1960 was presented to* **Dwight D. Eisenhower** *at a dinner held Tuesday evening, Jan. 10, 1961, in the Presidential Ballroom of the Statler-Hilton Hotel in Washington, D. C. The Medal, named for the first recipient, Herbert Hoover, was established in 1930 by the four founder engineering societies: ASCE, AIME, ASME, and AIEE.*

WAAIMES Plan for 90th Annual Meeting

The Woman's Auxiliary of AIME has planned a full program for the women attending the 90th Annual Meeting in St. Louis from February 26 to March 2. Registration begins on Sunday, February 25, from noon to 5 pm, and will continue on Monday, Tuesday, and Wednesday, February 27, 28, and 29, from 8:00 am to 5:00 pm.

The two major events on the women's program are the Tuesday luncheon and the WAAIME Annual Meeting to be held Wednesday morning. Also of special interest is the WAAIME round table scheduled for Tuesday morning. Cylvia A. Sorkin will be guest speaker at the Tuesday luncheon. She has a Ph.D. in economics and is a former university professor and Chairman of the Graduate School Division on Counseling and Personnel from Washington University in St. Louis.

As usual, the major social events of the Annual Meeting—the welcoming luncheon, dance, and annual banquet and reception—are open to the ladies, as are the society dinners, Scotch Breakfast, and Divisional luncheons. Tickets to all social functions may be purchased in advance. They will also be on sale at the Ladies' Registration Desk for as long as they last.

ROCK IN THE BOX

Mining & Exploration Division

Beginning with this issue of MINING ENGINEERING, Peter B. Nalle will be serving as *Rock in the Box* Editor for 1961. Mr. Nalle is currently superintendent of mining for Riverside Cement Co., Riverside, Calif. Before joining the company in 1951, he worked for St. Joseph Lead Co. in southeast Missouri.

1961 News Editor of Rock in the Box is Peter B. Nalle.

Mr. Nalle got his start toward a mining career in the early days of World War II when he came to California from his home town of Philadelphia to mine mercury at Almaden. Finding he liked the work, he transferred to the University of California at Berkeley to study mining, but was delayed in his work by two years of submarine duty in the Pacific. After the war he returned to Berkeley, where he received his B.S. in mining in 1947. He then went to Columbia University for graduate work, receiving an M.S. in mining in 1949.

Unit Committee Chairmen

The keystone to smooth functioning of M & E activities is the Unit Committee set-up, which caters to the special interests of Division members. We take pleasure in introducing your Unit Committee Chairmen for 1961:

Richard Maclin Stewart, Underground Mining Unit Chairman, is director of mining research for The Anaconda Co. at Butte, Mont. Since joining the company in 1948, Mr. Stewart has visited Anaconda's operations in Chile and has traveled extensively in the U.S., Canada, and Latin America visiting mining operations. He is one of the generation whose academic career was interrupted by World War II. He entered the Colorado School of Mines in 1940 and worked as a surveyor and miner during summer vacations. In 1943 he entered the U.S. Army Corps of Engineers and saw service in the European Theater. He returned to the U.S. in 1945, married, and resumed his studies at the Colorado School of Mines, graduating with an E.M. degree in 1948.

Mr. Stewart is a certified ski instructor and expert mountaineer. Both he and his wife, who has a B.S. degree in architectural engineering, are registered professional engineers in the state of Montana. Mr. Stewart is active in civic affairs in Butte.

Henry Schwellenbach is Open Pit Unit Chairman. He was recently made vice president—production, New York Trap Rock Corp., with which he has been associated since 1955. After graduating from Michigan College of Mining and Technology in 1938 with a B.S. in metallurgy, Mr. Schwellenbach worked in various gold mines in the West. He then joined The Anaconda Co. as a research engineer. In 1940 he went to Potrerillos, Chile, with Andes Copper Co. as a chemist and plant foreman.

During World War II he served as a gunnery officer for three years on destroyers in the Atlantic and Mediterranean theater of operations. On his return to the U.S. he again worked in various mining camps in the West. In 1947 he came East, going first to Tahawus as an assistant mill superintendent and then to Warren Foundry & Pipe Co. as mill superintendent in 1950.

Mr. Schwellenbach is married to the former Ruth Jones, whom he met in North Africa during the war. He is active in civic affairs such as Rotary, scouting, and the Dutchess County Society for Mental Health.

Chairman for the Geochemistry Unit is **Douglas Cook,** senior geologist for Bear Creek Mining Co. He came to Bear Creek in 1952 as an exploration geologist following a year as instructor at the Colorado School of Mines. Mr. Cook is a native of England and graduated from the University of Durham, England, in 1945 with a degree in mining engineering. He holds an M.Sc. degree from the University of Toronto and a D.Sc. degree from the Colorado School of Mines. He worked for the Londonderry Collieries Ltd. in England and from 1946 to 1947 was a junior mining engineer for Consolidated African Selection Trust Ltd. in Sierra Leone, West Africa. During the summers of 1948 and 1949 he served as senior geological assistant for the Ontario Department of Mines.

H. E. Harper, Chairman of the Geology Unit, has been chief geologist for Hecla Mining Co. since 1956, with an office in Spokane. His association with Hecla began in 1946 following two years of service in the U.S. Naval Reserve as communications officer in the Pacific area. Until his present appointment, Mr. Harper worked as mine and exploration geologist at various Coeur d'Alene district operations. He attended the University of Oregon for three years and then transferred to

(Continued on page 198)

R. M. STEWART

H. J. SCHWELLENBACH

D. R. COOK

H. E. HARPER

W. C. KELLOGG

Rock in the Box

(Continued from page 197)

Oregon State College, where he received a B.S. degree in geology in 1941 and a M.S. degree in geology in 1946.

The Geophysics Unit is headed by **William C. Kellogg,** currently chief geophysicist for Fairchild Aerial Surveys, where he is primarily concerned with mining geophysics, with responsibility for both air and ground surveys. He is a graduate of the Colorado School of Mines, receiving a degree as geological engineer in 1943. For the next three and a half years he served in the U.S. Army Air Corps as weather radar officer developing radar equipment for utilization in weather research. During that time Mr. Kellogg attended New York University, MIT, and Harvard. After his discharge in 1946 he attended Stanford University and the University of California at Los Angeles and worked as a research fellow in the Marine Physical Laboratory of the University of California in San Diego. He worked as junior observer for United Geophysical Co. and as geophysicist for Fairchild Aerial Surveys at the start of their airborne magnetic program. From 1950 to 1958 he was a geological-geophysical consultant until returning to Fairchild as a geophysicist in 1958.

Mr. Kellogg actively engages in tennis, skiing, swimming, golf, riding; he holds a private pilot's license, flying regularly for pleasure and on business.

Mining Geology Symposium

A feature of the coming Annual Meeting is a geology symposium dealing with the practical aspects of mining geology which should be of interest to many who would not ordinarily attend a geology session. The symposium is being held jointly with the Society of Economic Geologists on Wednesday morning, March 1. The subject of the symposium is *Mining Geology—Methods, Techniques, and Results.* Papers will be presented by Frank Snyder and James Odell, who will discuss the geological work at Bonne Terre; Edward Shea, who will discuss the use of geology at Butte; Arthur Baker III and William C. Scott, Callahan Mining Corp., who will discuss the role of mining geology and development at the Pitch Uranium mine in Colorado; Roger Blais and John B. Stubbins, who will discuss the geological work at the Iron Ore Co. of Canada operation in Quebec; and Allan James, who will discuss the use and application of geology at Kennecott's open pit operations. These papers have been selected to cover a wide range in types of mineral deposits and operations and should be of real interest to mining operators and management people.

M&E DIVISION NEWS EDITOR
Peter B. Nalle
Riverside Cement Co.
Box 832
Riverside, California

Agglomeration

(Continued from page 194)

A Progress Report on the Effect of Grind, Temperature, and Pellet Size Upon the Quality of Specular Hematite Pellets by D. M. Urich and Tsu-Ming Han, Cleveland-Cliffs Iron Co. **Shrinkage of Iron-Ore Pellets During Agglomeration** by H. U. Ross and A. Ohno, University of Toronto.

Technical Session 6—Friday, April 14, 1961—8:30 am to 12:00 noon.

Hot Briquetting of Partially Reduced Iron Ores by J. E. Moore and D. H. Marlin, Dravo Corp.

Agglomeration

(Continued from page 198)

Study of the Properties of Self-Fluxing Sinters by W. A. Knepper, R. B. Snow, and R. T. Johnson, U.S. Steel Corp.

Effects of Lime on the Sintering of Pure Hematite and Magnetite Concentrates by O. Nyquist, Jernkontoret, Stockholm, Sweden.

Fundamental Studies of Self-Fluxing Sinter by S. Watanabe, Sumitomo Metal Industries Ltd., Japan.

Structures and Bonding Mechanism in Sinters Made from Fine-Grained Australian Hematites by L. C. Bogan and H. K. Worner, The Broken Hill Proprietary Co. Ltd., Australia.

Luncheon—Author's Table—Friday, April 14, 1961—12:15 pm.

Technical Session 7—Friday, April 14, 1961—2:00 pm to 5:30 pm.

Pelletizing on a Horizontal Grate Machine by K. M. Haley and W. E. Apuli, Reserve Mining Co.

The Coarse Specularite-Fine Magnetite Pelletizing Process by K. E. Merklin and F. D. DeVaney, Pickands Mather & Co.

The Cooling of Sinter by P. A. Young and D. A. Barnard, Head, Wrightson & Co. Ltd., Yorkshire, England.

Factors Controlling the Cooling Rate of Sinter by D. D. Phelps and J. A. Anthes, Dravo Corp.

Limits of the Sinter Process by H. Wendeborn and F. Cappel, Lurgi, Frankfurt, Germany. *Paper to be printed but not presented.*

A Survey of the Literature Pertinent to Iron Ore Pelletizing by T. K. Goldstick, Jones & Laughlin Steel Corp.

The Registration fee for the Conference is $25 for AIME members, $27.50 for nonmembers. These fees include one set of preprints and one volume of Proceedings. Student fees —$3.50 for AIME student members, $5 for nonmembers—do not include preprints or Proceedings.

A special program has been arranged for the ladies, who will pay a registration fee of $1. It is calculated to keep them well occupied during the Conference sessions. On Wednesday afternoon the ladies have their choice of a tour of the Philadelphia Museum of Art or the Franklin Institute. On Thursday an all-day tour is planned taking in the Longwood Gardens, lunch at the Hercules Country Club (courtesy of Hercules Powder Co.), a tour of DuPont Co., and the Hagley Museum. The cost of this tour is $5 per person. On Friday morning a deluxe bus tour of Old Philadelphia is scheduled at $1.75 per person and in the afternoon a block of orchestra seats to a matinee performance of the Philadelphia Orchestra is available on a first-come, first-served basis. Tickets are $3.25 each.

Thursday evening has been reserved for the social events of the Conference, beginning with an All-Symposium cocktail party, followed by a fellowship dinner at which President Harnwell of the University of Pennsylvania will speak. The ladies are, of course, welcome. Informal dress will be the order of the evening.

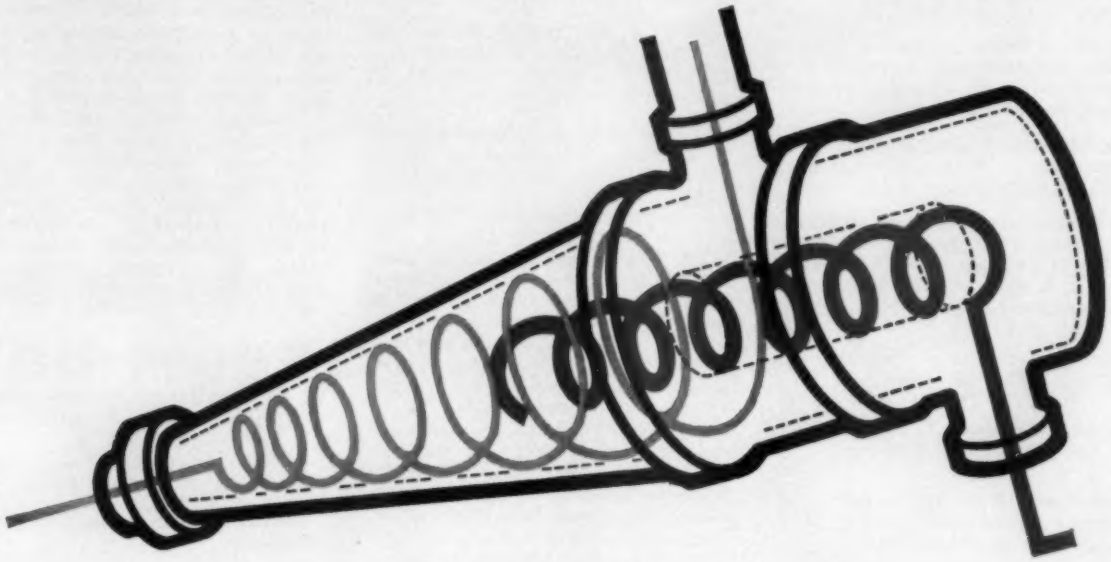
For information write:

W. B. Stephenson, General Chairman, International Symposium on Agglomeration
P. O. Box 635
Paoli, Pa.

Registrants can have their mail addressed:

c/o International Symposium on Agglomeration
P. O. Box 635, Paoli, Pa.
Cables: c/o ASH-FRAZERPENN

DUTCH STATE MINES
HEAVY MEDIUM *Cyclone* WASHER



1960 OPENED A NEW ERA
IN THE PRODUCTION AND MARKETING OF COAL

Installations of the Dutch State Mines Heavy Medium Cyclone Washing System in the United States during 1960 demonstrate new marketing and profit opportunities for the industry.

It is now possible, on a continuing production basis, to meet the critical requirements of public utility and industrial plants for premium quality, uniformly graded coal. *It is being done today in the American market!*

The Heavy Medium Cyclone Washing System cleans fine coal cleaner than by any other cleaning method.

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The efficiency of the Dutch State Mines Heavy Medium Cyclone Washing System has been proved in more than 40 successfully operating plants in 15 countries throughout the world. It is available in the United States exclusively through Roberts & Schaefer. Installations can be made in your present facilities as well as in a completely new plant.

A Roberts & Schaefer engineer will be glad to give you complete information.

Since 1903, Roberts & Schaefer has pioneered in the engineering of advanced plant design and facilities for the preparation of coal. Introduction of the Dutch State Mines Heavy Medium Cyclone Washer in the American market carries on the R&S tradition of leadership in the field. Roberts & Schaefer provides a complete service covering initial process studies, design and engineering, installation and construction.

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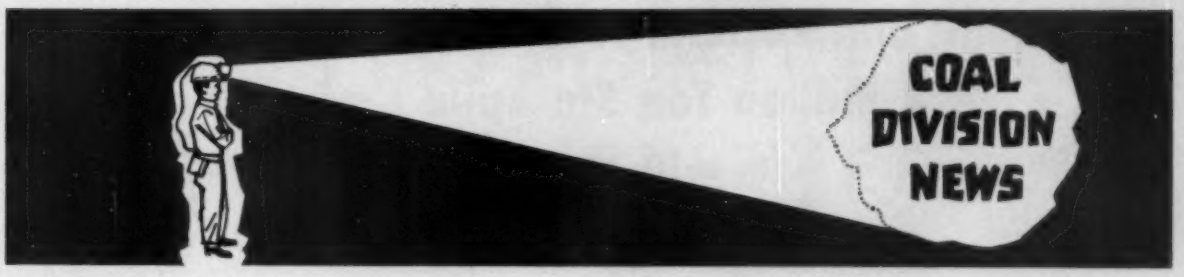

R. E. Dawson Appointed Division News Editor

With this issue of MINING ENGINEERING, Raymond E. Dawson takes over the editorship of *Coal Division News* for 1961.

Raymond E. Dawson

Your Newsletter Editor hopes that during the coming months you will let him know the kind of news you would like to read—and, more especially, that you will send him news that will be of general interest to Coal Division members.

For the past 35 years Mr. Dawson has been in the employ of Roberts & Schaefer Co., except for short periods of employment with Republic Steel Corp. and Heyl & Patterson Inc. A graduate of the University of Cincinnati, he started with Roberts & Schaefer in the Field Construction Dept., serving as superintendent of construction. Upon finishing construction of Republic Steel's Clyde mine preparation plant at Fredericktown, Pa., in 1943, he was employed by Republic Steel as superintendent of the plant. In the latter part of the following year he joined Heyl & Patterson Inc. in Pittsburgh.

Returning to Roberts & Schaefer in 1945, he was assigned as assistant plant superintendent of the Harvey, Ill. fabricating shop, a position he held until 1948, when he was transferred to the Chicago office in the engineering department, serving in various supervisory capacities. In 1953 he became superintendent of plant performance. His present post is that of assistant to the president.

Mr. Dawson took an important part in the Roberts & Schaefer development of air-washing fine coal and, with this background of experience, conceived the invention of the Dawson Air Jig. He was issued a patent for this machine in May 1958 and assigned all rights to his employers.

In his home community of Riverdale, Ill., Mr. Dawson, his wife, and son are all members of the Ivanhoe Reformed Church, and as Institutional Representative for his church he has been active in work with the Boy Scouts. He is also personally interested in sponsoring teen-age baseball and basketball.

Chicago Meeting

The December 7 meeting of the Chicago Section* was one of special interest to coalmen. As chairman for the Coal Group Will Mitchell, Jr., director of research, Allis-Chalmers Mfg. Co., introduced the two speakers of the evening, W. C. Campbell and D. B. Lanier.

Mr. Campbell, who is assistant to the president, Old Ben Coal Corp., discussed the company's No. 9 mine and the new operation at Mine No. 21. At No. 9 mine two shifts are producing 10,000 tpd from the No. 6 Illinois seam, which is 100 in. thick. In 1959 the company shipped more than 2 million tons of coal from the mine; the 1960 production will be about the same.

The mine was opened in 1912 with hand loading and was shut down in 1927. In 1945 it was reopened with modern equipment but with no basic change in room and pillar mining plan. The coal recession of '52 and '53 indicated a need for cooperative effort to effect more economical mining methods, and the Goodman 500 miner was developed and placed in operation in 1954 with immediate success.

Mine No. 21 was started in April 1956, and coal was first hoisted on Jan. 4, 1960. Operating on three shifts, this mine produces 10,000 to 11,000 tpd. It taps a reserve of 100 million recoverable tons of low-sulfur coking coal 670 ft below surface. Production for 1960 will be about 1.5 million tons. Goodman Type 405 continous miners are used with shuttle cars and belts to convey the coal to panel mouth. Ultimately they will combine pit cars and belt haulage. Supplies are delivered by track to panel mouth and then by battery jeeps. The mining plan used at No. 9 is also used at No. 21. A unique method of hanging the ropebelt conveyor from the roof bolts obviates the necessity for constantly realigning the belts because of shifting floor supports.

Coal from the No. 21 mine is brought to the surface by an automatic hoist at the rate of 800 tph. The 6 x ¼-in. raw coal is processed in a Baum-type jig 96 in. wide; raw coal under ¼-in. size is air-washed by four Super Airflows.

Mr. Lanier, chief electrician at Peabody's River King mine, gave an illustrated talk on the mine operations. This mine is located near Freeburg, Ill., about 30 miles from Peabody's Mississippi loading dock at East St. Louis, Ill. Since it went into operation in August 1957, the River King has expanded until it is now the largest strip mine in Illinois. Production from this mine replaces the output of three earlier operations—the St. Ellen, River King, and Seminole mines. The St. Ellen, one of the oldest mines in Illinois, was closed in 1960 when additional stripping capacity was made possible by use of the excavating wheel. The Seminole mine was also closed last year. Four factors governed present selection of the mine site: coal reserves at this location; suitability for stripping operations; nearness to industrial markets; proximity to Mississippi River transportation.

Operated by a five-man crew, Peabody's modern preparation plant processes 1200 tph of precision-sized, washed, dried, and oil-treated coal. The plant produces approximately 10,000 tpd, the equivalent of 200 railroad carloads.

* *The 1961 officers of the Chicago Section are listed in the report on page 207.*

New Coal Subsection

Most vital news to coalmen in the midwestern area since the Coal Division was inaugurated is the estab-

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Coal News

(Continued from page 201)

lishment of the Midwestern Coal Subsection of the St. Louis and Chicago sections. This group is designed to bring together coalmen from Illinois, Indiana, West Kentucky, and Missouri. H. Eugene Mauck, of Freeman Coal Mining Co., provided the necessary organizing drive as a result of the interest shown at the AIME St. Louis Section—SME Coal Division Meeting held in St. Louis September 8 and 9.

At the opening meeting in Benton, Ill., Oct. 27, 1960, Mr. Mauck was named temporary chairman and Chester Hodgson temporary secretary-treasurer. The Executive Committee of the St. Louis Section has already voted to release all Coal Division members for the formation of the new Subsection. The Chicago Section is expected to take similar action.

A second meeting was held November 22 at Ferris's Cafe, south of Johnson City, Ill., to formulate plans for the Midwestern Subsection's future activities. There is reason to hope that between 30 and 50 coalmen not now affiliated with AIME will join this Subsection.

If you operate in the midwestern area, here is your opportunity to become part of an organization that extends beyond state lines to bring the men of the coal industry together for discussions and programs.

Speaker at Coal Division Luncheon

Ing. Jose Perez Larios of the Department of Natural Resources, Mexico City, will address members of the Coal Division at their annual luncheon, Tuesday, February 28, in St. Louis. Mr. Larios worked in the mines in Mexico and attended the University School of Mines. Coming to this country under the sponsorship of the Bank of Mexico, he worked for two years as a crew member in U. S. underground mines to gain experience in modern mining methods.

Mr. Larios is now in charge of prospecting for minerals and is head of the Coal Division of the Department of Natural Resources, Mexico City. He is thoroughly acquainted with the coal deposits in Mexico and will speak on that subject.

COAL DIVISION
NEWS EDITOR
RAYMOND E. DAWSON
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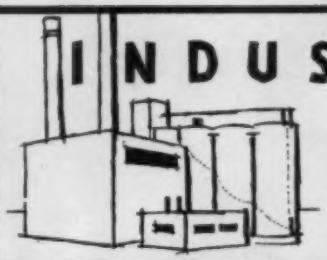


INDUSTRIAL MINERALS NEWSLETTER

Dear Members of IndMD:

This issue should reach your mail boxes just before our meeting in St. Louis. The meeting program, as published in the December MINING ENGINEERING, represents much hard work on the part of Dick Lund and his committees, and we are privileged to look forward to a series of papers to satisfy a broad range of interests.

Chairman-Elect Carl F. Clausen has practically completed his roster of committee personnel. Warren R. Wagner, consulting geologist, will head the Membership Committee. The Program Policy Committee, successor to the previous Arrangement of Commodity Committees, consists of Ralph G. Kazmann, chairman for a term of one year, and five vice chairmen representing the new commodity classifications. The five vice chairmen are Richard J. Lund, for a one-year term, representing Class VI; Paul M. Hedley, for a two-year term, representing Class I; J. Messel, for a two-year term, representing Class IV; J. C. Bradbury, for a three-year term, representing Class II; and Oscar Wicken, for a three-year term, representing Class III. This arrangement is designed to provide continuity of the group responsible for meeting programs rather than the previous system of having a new group starting from scratch each year.

The classification of industrial minerals used for the new Program Policy Committee arrangement is based on the major or predominant application(s) of each of the minerals or rocks. Some are included in one or two classes and may yet have minor uses in other classes. The six classes are:

I Minerals for Construction Materials
II Minerals for Chemicals and Chemical Processes
III Minerals for Ceramics and Refractories
IV Minerals for Fillers, Filters, and Abrasives
V Industrial Waters
VI Minerals for Special Uses

Class II is the largest group. It does not include such minerals as may be used in equipment (filters, for example) for chemical processing. It does include such uses as fluxes in metallurgical processes. The term *chemicals* is used in the broad sense to include such materials as paint, fertilizers, etc.

October 1961 seems still far away, but it is none too early to be planning for the joint IndMD-CIMM meeting in Ottawa. Our representative John G. Broughton will be pleased to hear from anyone wishing to contribute a paper. John's address is:

N. Y. State Geological Survey
State Education Bldg.
Albany 1, N. Y.

This issue is your editor's last assignment as Editor and Secretary-Treasurer of the Division. It is a pleasure to acknowledge the contributions of news items by many of the regional vice chairmen. A final word to the membership-at-large; your Newsletter Editors will always welcome contributions of news items, however brief, on events, people, and new industry developments. Also of value are your comments and criticisms so that the Newsletter may be of greater service to all. *John S. Holland.*

Honorary Members

(Continued from page 195)

held until 1952. He had become Chairman of the Board in 1951 and continued in that capacity and as chief officer of the company until April 1960, when he retired.

Mr. Thompson was born in Portland, Maine, and attended Columbia University School of Mines. Before joining The International Nickel Co. he was assistant in metallurgy at the School of Mines.

Carl E. Reistle, Jr.

Carl E. Reistle, Jr., executive vice president and member of the Board of Directors of Humble Oil & Refining Co., has been associated with the company since 1936, when he went to work as engineer-in-charge of the Petroleum Engineering Div. He began his career in the oil business by working as a roustabout for the Carter Oil Co. during summer vacations while he was attending the University of Oklahoma. Soon after graduation he joined the U.S. Bureau of Mines as a junior petroleum chemist and remained with the Bureau until 1933, when he became chairman of the East Texas Engineering Assn., a cooperative organization formed to gather engineering facts on the efficient operation of the East Texas field.

Mr. Reistle, a Past-President of AIME, was the 1958 recipient of the Anthony F. Lucas Gold Medal.

Rene V. M. Perrin

René Victor Marie Perrin was born in Grenoble, France. He entered École Polytechnique and then the Corps des Mines as an engineer. In 1920 he left Corps des Mines and joined Ugine, where he made a lifelong career for himself. He is presently Chairman of the Board and president. From the beginning he displayed an interest in the manufacture of special steels. In 1932 he developed a new steelmaking process by intermixing liquid metal with special liquid synthetic slags to obtain rapid reactions, thus initiating what is known as *quick metallurgy*.

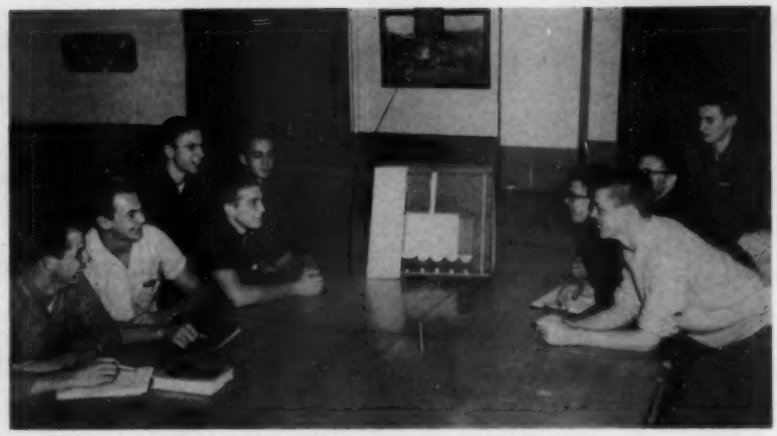
Education News

Survey Shows Engineering Teachers' Income Rises

A recent report by the Engineering Manpower Commission of Engineers Joint Council revealed that the average total professional income of engineering teachers has increased by 14.7 pct in the past two years. The survey, made possible through a grant from the National Science Foundation, covers more than 5000 engineering teachers, over half the total number. Of the average total income of engineering teachers, 77.5 pct is basic teaching salary and the remainder is derived from outside professional work such as consulting and research. Since the survey was first made in 1956, average basic teaching salaries have risen 31.1 pct and income from outside sources 11.3 pct. Today's average basic teaching salary for engineering teachers in American colleges is $8534. It is supplemented by an average of $2479 from outside professional income.

Mackay School of Mines Begins Visiting Professor Program

In a move to bring a number of the country's leading mineral authorities before the Mackay School of Mines, Dean Vernon E. Scheid, under the Mackay Endowment Fund, named Walter H. Voskuil, mineral economist, the first Distinguished Visiting Professor for the current academic year. Attesting to the interest developed by this move is the fact that in addition to students regularly enrolled in the class, the lectures are being attended by faculty of the school, geological and engineering staff members of the Nevada Bureau of Mines, and visiting members of the mining profession. In addition to the classroom program, several all-university lectures have been planned to which the public will be invited.



Penn State Inaugurates Student-Trainee Program

Pictured above are some of the freshman students enrolled in Penn State's new five-year work-study plan in mining engineering. Under the program they will alternate periods of attendance at Penn State with on-the-job experience in the mining industry. The program went into effect on July 25 in cooperation with 17 companies representing all segments of mining. It is one of the few such programs in existence in the U.S. designed exclusively for mining engineering. Under the arrangement, a company selects a pair of young men for whom a single job is provided and the student-trainees alternate six-month periods of work study, one trainee being at Penn State while the other is on the job. Under this arrangement students gain two years of practical experience while earning their B.S. degree.

The Anaconda Co. Establishes Graduate Scholarships

Five scholarships for graduate students in mining, metallurgical, or geological engineering have been established at Montana School of Mines by The Anaconda Co. The scholarships are provided for new engineering employes of the company who have the necessary qualifications for advanced study. Recipients will be chosen from this group by the School of Mines Scholarship Committee each year, beginning with college seniors who graduate in 1961 and accept employment with Anaconda. The scholarships are to be given to outstanding students who have demonstrated exceptional scholastic aptitude and promise of future achievement. It is expected that they will be graduates of engineering schools throughout the U.S. who have taken employment with the company in Montana.

Anaconda will provide $7500 annually to maintain these scholarships. In addition, the student himself will be required to pay $200 to the school toward the partial defrayment of his expenses. Under the program the students will be employed full time by the company at full salaries for the jobs to which they are assigned. Arrangements between the school and the company will enable the student employe to complete his academic work at the school while working on company research projects which have the approval of the school.

Florida Section Sets Up Annual Scholarships

The Florida Section voted at its last meeting in 1960 to set up two $400 per year scholarships for deserving engineering students at the University of Florida. These scholarships will be awarded on an annual basis to students who have completed two years of basic study and have been accepted for admission to the engineering school. Screening of applicants will be done by a committee from the school. Final selection will be made by a committee from the Florida Section.

Notice to MBDers

The last issue of the *Newsletter* and the November *MBD Digest* both promised a third edition of the *Newsletter* for 1960, which would be an MBD guide book for the 1961 Annual Meeting. However, we must loudly announce that there will be no third issue because there are no funds.

MBD supports the *Newsletter* independently. No funds are available from the parent organization for this purpose. The Double-Buck-of-the-Year would support our *Newsletter* most adequately—in fact, luxuriantly. Have you sent in your Double Buck yet? Please do—MBD needs YOUR (dollars).

Since we can't publish our guidebook edition, we will have to compromise with this check list of events of interest to MBD'ers. Together with 1244 to 1247 from the December issue of MINING ENGINEERING, this checklist will outline all functions.

Monday, February 27

9:30 am, Starlight Roof
Crushing and Grinding ☐

12:15 pm, Khorassan Room
AIME Welcoming Luncheon ☐

2:30 pm, Starlight Roof
Concentration ☐

6:00 pm, Exhibit Area
Social Hour ☐

8:00 pm, Khorassan Room
Dinner-Smoker ☐

Tuesday, February 28

7:30 am, Chase Club
Scotch Breakfast ☐

9:00 am, Starlight Roof
Chemical Process ☐
(Joint Session MBD-EMD)

Free Afternoon

7:00 pm, Starlight Roof
SME Dinner ☐

9:00 pm, Khorassan Room
All-Institute Informal Dance ☐

Wednesday, March 1

9:00 am, Tiara Lounge South
Materials Handling and Mill Design ☐

9:00 am, Starlight Roof
Basic Symposium on Kinetics and Design ☐
(Joint Session MBD-ISD-EMD)

2:00 pm, Tiara Lounge South
Materials Handling and Mill Design (cont.) ☐

2:00 pm, Starlight Roof
Basic Symposium on Kinetics and Design (cont.) ☐

Thursday, March 2

9:00 am, Starlight Roof
Solid Fuel Separation ☐

12:15 pm, Chase Club
MBD Luncheon ☐

2:00 pm, Starlight Roof
Operating Control ☐

2:00 pm, Zodiac Room
Pyrolysis and Agglomeration ☐

All events at Chase and Park Plaza Hotels.

COME TO ST. LOUIS (AND BRING YOUR DOUBLE BUCK WITH YOU!)

W. T. Marston, Secretary-Treasurer.

50th Anniversary of Froth Flotation

At a series of meetings in Denver this fall, the preliminary work of several years took shape in final plans for an occasion that will be of world-wide significance to beneficiation men. Sponsored by the Minerals Beneficiation Division of SME, the Commemoration of the 50th Anniversary of Froth Flotation in the U. S. A. will be held in Denver Sept. 17-20, 1961. The event will be marked by the publication of an Anniversary Volume and by international participation in a program comprising six sessions, each with five papers, covering those theories, practices, and developments of real purpose which are not already classed as proved and accepted in the science of froth flotation:

I. Flotation and Promotor and Depressor Action.
II. Mechanics and Kinetics of Flotation.
III. Present Flotation Practice.
IV. Overall Milling-Circuits Design and Effects on Mining and Smelting.
V. Flotation Mill Control.
VI. Preparation of Ore and Minerals for Flotation.

Papers to be presented will be preprinted by the Colorado School of Mines, probably as one of the School's regular quarterly bulletins. The bound papers will be available for the Symposium sessions.

The Anniversary Volume, as distinguished from the Symposium papers, is a comprehensive reference now being compiled under the direction of D. W. Fuerstenau. Although not primarily historical, it will include the accepted theories and practices of froth flotation up to the present time. Individual papers from the Symposium will not appear in this anniversary volume, but undoubtedly some of the Conference authors will contribute to various chapters.

Both the cost of the Anniversary Volume ($8.00) and the cost of the preprints ($2.75) will be included in the registration fee.

Arrangements are headed by the following Committee Chairmen, who were among those serving at the initial planning sessions:

Executive Chairman	J. D. Vincent
Finance Chairman	D. W. Scott
General Chairman (Symposium)	F. E. Briber
Program Chairman (Symposium)	Hildreth Frost
Editorial Chairman (Anniversary Volume)	D. W. Fuerstenau

At a fall planning session in Denver the General Chairman, F. E. Briber, announced the names of the local committee chairmen:

Arrangements and Meeting Places	W. T. Ahlborg
Publicity	O. W. Walvoord
Finance	F. E. Briber
Papers for Sessions	Hildreth Frost
Publication and Translations	Truman Kuhn
Banquet	E. D. Dickerman
Ladies	Mrs. Fred Smith
Luncheons	R. D. Moody
Scotch Breakfast	E. H. Crabtree
Cocktail Parties	A. L. Hill
Registration	Clyde Johnson

As plans for this anniversary symposium progress, the actions taken by each committee will be reported.

Around the Sections

• The following officers were elected for 1961 at a business meeting of the **Utah Section** held November 17 at the University of Utah Union Building Little Theater: Oscar A. Glaeser, chairman; Alvin J. Thuli, Jr., 1st vice chairman; J. Bruce Clemmer, 2nd vice chairman; and Karl K. Lacher, secretary-treasurer. Other events of the meeting were the presentation of a membership award to Joe Norden for securing five new members and to George A. Jump, a senior at the University, for securing five student memberships. Winners of the Utah Section Prize Paper Awards were announced. There were no papers submitted in the undergraduate category. In the graduate category, first prize went to Timothy Moss for his paper *Oxidation of Flat Magnesium Surfaces* and second prize to Philip M. Wright for *Lead Industries in the USA.*

The program following the business meeting was conducted by a panel of distinguished geologists, who discussed current exploration projects in the western states, Missouri, and the Scandinavian countries. Roland B. Mulchay of The Anaconda Co. served as panel moderator. The participants were Douglas R. Cook, Bear Creek Mining Co.; Richard F. Durfee, Boyles Bros. Drilling Co.; and John C. Osmond, consulting geologist.

• The November 10 meeting of the **Southeast Section** was a banquet held at the Guest House Inn in Birmingham, Ala., honoring Milton H. Fies, who received a certificate and 50-year pin for service with AIME. Mr. Fies, an engineer with Alabama Power Co., is especially noted for his work on underground gasification of coal at Gorgas. Keenly aware of the efforts of the USSR in the field of gasification, Mr. Fies has directed his energies toward perfecting this process.

AIME President J. L. Gillson was principal speaker of the evening. He took the audience on an archeological tour of Mexico via colored slides.

• Members of the **Exploration Subsection** (Upper Peninsula Section) and their wives gathered at Mather Inn, Ishpeming, Mich., November 9 to hear James Neilson discuss highlights of the International Geological Congress and see his colored slides of Denmark, Norway, and Sweden.

• The **Ajo Subsection** (Arizona Section) met November 10 at the Copper Coffee Shop. The program was presented by four representatives of the Link-Belt Co. The subject, the German L.M.G. excavating wheel, was covered by an introductory talk, a film, and a question and answer period.

• A joint meeting of the **El Paso Section** and AIEE was held November 9 in the ballroom of the Hotel Cortez. Guest speaker of the evening was J. K. Howell, region engineering manager, Westinghouse Electric Corp., St. Louis. His talk, *Thermoelectricity and Methods of Future Power Generation,* was illustrated by slides, motion pictures, and some apparatus.

• New officers were announced at the first meeting of the **Student Chapter** of the **Pennsylvania State University** as follows: Charles Rich, president; Donald Roberts, vice president; Joseph Conway, secretary. John Demchalk, faculty advisor of the Society, gave a short talk in which he explained the aims of AIME and pointed out the many benefits derived from membership in the organization.

• The **Lima, Peru Section** held its monthly luncheon meeting in the American Room of the Hotel Bolivar on Nov. 23, 1960. The meeting featured three talks. Hermen Hartjens, manager, Mining Div., Cyanamid Inter-American Corp., gave a general review entitled *Some Contributions to Lead-Zinc Metallurgy as Applied to Peru;* Jorge E. Gutierrez, mill superintendent, Tamboraque, discussed grinding and regrinding in the Tamboraque concentrator; and G. Mitton, senior metallurgist, Cerro de Pasco Corp., presented a talk *Factors Governing the Separation of Lead by Flotation from Ores of the Cerro de Pasco Corp.*

• The **Black Hills Section** held its annual election of officers during the Fall meeting on the campus of the South Dakota School of Mines and Technology in Rapid City. Those elected were: E. H. Oshier, chairman; Joel Waterland, 1st vice chairman; Paul H. Anderson, 2nd vice chairman; and Paul DuMontelle, secretary-treasurer. Elected to the executive board of the Section were: John Broome, Fred Moseley, Harold Webb, and Herbert Weisz.

Following the election William Laval, professor of geology at the South Dakota School of Mines, presented a geological travelogue of a recent tour of Europe.

Milton H. Fies, center, receives a certificate honoring his 50 years of AIME membership. At the left, AIME President J. L. Gillson, at the right, E. P. Reed, Southeast Section chairman.

Dinner over, guests at the Southeast Section banquet honoring Milton H. Fies sit back and enjoy a period of relaxation and informal conversation before the formal program gets under way.

• The **Mining Society of The Pennsylvania State University** (AIME Student Chapter) heard Joseph L. Leonard, research technologist for U. S. Steel Corp., discuss *Coal Pulverization for Carbonization* at a meeting on November 17. Mr. Leonard's talk covered both the selection of equipment and the process.

• Sixty-two members of the **St. Louis Section** attended a meeting at the Hotel York on November 11 at which the 1961 slate of nominees were elected to office. The new officers are: V. W. Buys, chairman; R. H. Lowe, vice chairman; Carl E. Paden, secretary-treasurer; and G. M. Bell, past-chairman.

The speaker for the evening was Bruce E. Kester, technical director, Missouri Portland Cement Co., whose topic was *Design and Performance of Ball Mills.*

On December 9 the Section met to hear an illustrated talk, *Trends in Iron Ore*, by L. A. Roe, director of mineral processing for International Mining & Chemical Corp. After reviewing the general history of iron ore beneficiation, Mr. Roe discussed the economics of ore preparation, new developments in direct reduction of ores, and the future of iron ore beneficiation.

• On Dec. 7, 1960, the **Chicago Section** held an unusually well attended meeting. The Program Committee, which is responsible for the current session has been conducting a determined drive to regenerate local interest in AIME affairs among the more than 400 SME members living in the Chicago area. It has arranged a series of meetings through the winter and spring which will either be of interest to all AIME members or consist of separate sessions for metallurgists and miners.

This meeting was the first such split session. Nearly 200 people were in attendance at the dinner—approximately twice as many as expected—and roughly half of these were members of SME. After the dinner the Chairman of the Nominating Committee presented the slate of officers for the coming year: Chairman, John V. Russell; Secretary-Treasurer, M. E. Nickel; Assistant Secretary-Treasurer, John F. Collins; Members-at-Large: C. F. Clausen, F. R. Hunter, and D. A. Dahlstrom. Following the business meeting, the metallurgists heard from T. O. Dormsjo, manager, Steel Div., Stora Kopparberg Corp. and D. R. Berg, manager, New Product Development Dept., Dravo Corp., who presented a sound-color film of the Domnarvet, Sweden steel works showing the operation of the original 30-ton capacity Stora Kaldo furnace. Its applications to steelmaking conditions in the U. S. were discussed.

Pictured during the Intermountain Subsection tour of Colorado Fuel & Iron Corp. steel plant at Pueblo, front row, left to right: Tony Corbetta; Norm Grauerholz; John Schroeder; Dick Gott; Fred Bender, Intermountain Subsection chairman; Prentice Cain; Andy Lambertson. Standing: Harold Newton, Walt Munn, Ray Allen, Gene Moss, Bill Gregory, Rex Foster, Bob Craig, Pete Klussman, Cliff Arner, Hank Cooper, Jack Merchant, Bill Williams, Bud Eyer, and Walt Crow. The lady is Mrs. Fred Bender.

The SME members attended a session on developments in coal mining equipment and methods in Illinois by W. C. Campbell, assistant to the president, Old Ben Coal Corp., and D. B. Lanier, chief electrician, Peabody Coal Co., River King mine. (For details of these talks see page 201, Coal Division News.)

Before the presentation of these papers Frank R. Hunter, Mid-Continent Vice Chairman-Elect of the Industrial Minerals Division conducted a discussion of methods whereby the renewed interest of SME members could be systematized and continued.

• The third meeting of the **Midwestern Coal Subsection** (St. Louis and Chicago Sections) was held Jan. 19, 1961 at Ferris's Cafe south of Johnson City, Ill. The speaker of the evening was Harold Jackman, Illinois Geological Survey, who presented a talk entitled *Illinois Coking Coal in Metallurgical Use.*

About 75 people, members of the **Bisbee-Douglas Subsection** (Arizona) and their wives, attended a banquet meeting at the Warren District Country Club on November 19. Budd L. Peabody, assistant vice president in charge of business development, First National Bank of Arizona, Phoenix, was speaker of the evening. His subject was *The Future Role of Banking in Industry.* Mr. Peabody referred to the next 10 years as the *soaring sixties* and stated that the crucial test of domestic industry during this period will be the ability to compete internationally. He said that banking's greatest concern will be capital shortages due to the anticipated growth of the U. S. Other representatives of the bank present were Joseph Muheim, vice president, and John Swanner, manager of the Bisbee branch.

The following people were elected Subsection officers for 1961: S. C. Holmes, chairman; G. A. Dahlke, vice chairman; C. A. Wenner, secretary-treasurer; and S. Towle, membership chairman.

• The **Intermountain Subsection** (Colorado Section) took a field trip through the steelmaking facilities of The Colorado Fuel & Iron Corp. at Pueblo, Colo., on October 3.

• The **Ajo Subsection** (Arizona Section) held its annual Christmas party for members and their wives December 8 at the Ajo Country Club. The affair began with a cocktail hour, followed by dinner.

• The December 6 meeting of the **Washington, D. C. Section** was notable on two counts—AIME President Joseph L. Gillson was guest

AIME President J. L. Gillson, and SME Secretary J. C. Fox were guests of the Washington, D. C. Section in December.

speaker and it was the occasion of the Section's annual business meeting. Following dinner in the dining room of the Broadmoor Apartments, Dick Smith, 1960 Section Chairman, called the meeting to order. Guests, including John C. Fox, SME Secretary, were introduced, after which the meeting got down to the business of the evening. Albert E. Schreck, treasurer; Harold Kirkemo, chairman of the membership committee; and Sidney Gottley, chairman of the Building Fund committee, each reported improvement in his department over last year and asked for continued cooperation. A report was also given by Arno Fieldner, Section Delegate to the D. C. Council of Engineering and Architectural Societies.

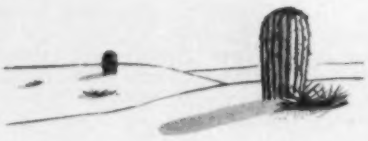
R. L. Faulkner, chairman of the nominating committee, presented the slate of officers for the coming year; as there were no additional nominations from the floor they were voted into office unanimously. The new officers are: John T. Croston, chairman; Paul Allsman, Charles W. Merrill, and John T. Sherman, vice chairmen; Harold Kirkemo and Horace Reno, council members; and Donald Frendzel, secretary-treasurer.

In response to a call for new business, Leon Dupuy moved that the Washington, D. C. Section request the SME to reconsider the recently adopted publications policy of the Society. His motion was amended to the effect that this matter be brought before the Council of Section Delegates on Saturday, February 25, 1961. The amended motion was carried after a good deal of discussion and debate. The meeting then settled down to hear President Gillson's talk on petrochemicals. Before introducing his topic of the evening, Dr. Gillson spent a few minutes discussing Institute affairs.

• More than 100 members, their ladies, and guests attended the **Lehigh Valley Section** annual dinner meeting on December 2 at the Lehigh Valley Club in Allentown, Pa. Election of officers for 1961 was the main point of business. Nathan Brown, chairman of the nominating committee, reported the committee's nominees, and since there were no nominations from the floor the following Section members were declared elected: Henry J. Burnell, chairman, and Stanley A. Ward, Carl B. Post, and Robert T. Renfrew, vice chairmen. Nathan Brown continues as Section Delegate and Robert W. Sleeman as Alternate Section Delegate.

Dr. Gillson, speaker of the evening, first said a few words about AIME matters, noting in particular that the Lehigh Valley Section had exceeded its quota to the United Engineering Trustees Building Fund by about 50 pct. He then launched into his main topic, *The History of Early Civilization in Mexico and Yucatan.* Following his talk, he answered questions from the audience.

• Members of the **Tucson Subsection** (Arizona Section) met November 9 at Holiday Inn to hear a talk on the LMG bucket wheel excavator by Kirk Carlton, engineer with Link-Belt Co.'s mining division, and his associates Earl Bugby and John Hamlin. The talk was illustrated by slides and a film, *Performance Proven.*



• "All roads lead to Tucson" could have been the phrase applied to this area on December 5 when the **Arizona Section** held its annual meeting at the Pioneer Hotel. More than 500 registered for the technical sessions, and almost as many, including about 200 wives, attended the evening banquet. The heavy registration and the interest of members attending the various technical meetings held during the day gave evidence to both the strength of the Section and the excellent program developed by H. E. Krumlauf and members of the Technical Meetings Committee.

In the morning there were sessions on mining geology, underground mining, and smelting. At the geology session three papers were presented dealing with geological interpretation at the Palo Verde mine based on diamond drill cores; increased core recovery through applied mud control; and the carbonate-host type of ore deposit. In the underground mining division there was a paper on development of the Christmas mine and a paper on pressure grouting for ground stabilization in the San Manuel mine. The smelting session was devoted to a consideration of some phase diagrams for copper metallurgy.

In the afternoon those attending the session on mineral dressing heard talks on the necessity for classification of mineral combinations and X-ray assay of mine, mill, and smelter products. Those attending the open pit mining session heard four papers, dealing with computers and their application to mining.

AIME President-Elect Ronald R. McNaughton and managers of the principal mining companies in Arizona met with President Richard A. Harvill of the University of Arizona to discuss educational standards for entry into the engineering field and curriculum requirements, as well as the need to stimulate interest in the minerals industry. Later Mr. McNaughton spoke to a group of students from the College of Mines presided over by D. M. Wright, president of the student section of the University.

The social high point of the meeting was the cocktail party and dinner held in the hotel ballroom. Mr. McNaughton, speaker of the evening, gave a brief résumé of the general state of AIME and then talked about the early days of his company, The Consolidated Mining & Smelting Co. of Canada Ltd. Guests at the banquet were Richard A. Harvill, president of the University of Arizona, and Don Hummel, Mayor of Tucson.

The evening session opened with a tribute to R. W. Hughes, who died Sept. 10, 1960. Mr. Hughes served for many years on the Board of

A conference with Richard A. Harvill, President of the University of Arizona, was a feature of the annual meeting of the Arizona Section. Those attending are seated, from left: A. P. Morris, B. R. Coil, T. A. Snedden, Ronald R. McNaughton, Richard A. Harvill, Walter C. Lawson, E. O. Kirkendall, C. P. Donohoe, and H. Carroll Weed. Standing, from left: J. D. Forrester, D. F. McElhattan, J. B. Pullen, Clifford J. Hicks, P. S. Geshell, Donald F. Wright, George E. Atwood, and T. G. Chapman.

Directors of the Section. (See "Obituaries," page 215)

Richard F. Hewlett and Louis B. Thoreson were this year's winners of the annual contest sponsored by the Section for students of the University of Arizona. The first prize went to Mr. Hewlett for his paper entitled *The Application of the Digital Computer to the Calculation of Ore Reserves.* Mr. Thoreson received the second prize for his paper *Concave Parabolic Die Plate for Aluminum Extrusion Press.*

Announcement of the 1961 officers was made during the course of the evening. The current officers were re-elected as follows: W. C. Lawson, chairman; T. A. Snedden, 1st vice chairman; and B. R. Coil, 2nd vice chairman.

• The **Southwestern Alaska Section** has been carrying out a busy program during the fall season. At the meeting on September 19, members heard an interesting and informative talk on helicopter operations by Link Luckett. At the Section meeting October 17, held at the State Department of Mines building, Leo Saarela, U. S. Geological Survey, gave a talk on the work of the USGS in Alaska. The November 21 meeting featured the election of officers for 1961. The new officers are: Odin Strandberg, chairman; Tom Wyman, vice chairman; and Irwin W. Mitchell, secretary-treasurer. Glen D. Chambers, Leroy Gunnarson, and Roderick W. B. Saunders were elected to the Board of Directors. Following the election Elmer Rasmuson, president of the Bank of Alaska, gave a talk entitled *Economic Effects of Price of Gold on the World Market.*

The following committee appointments have been announced: Martin Jasper, chairman of the program committee; Tom Marshall, chairman of the membership committee; and Charles F. Herbert, chairman, 1961 Mining, Minerals, and Petroleum Conference. Members of Mr. Herbert's committee are Glen D. Chambers, William J. Strandberg, Harold D. Strandberg, Rich Richards, Martin Jasper, Bill O'Neill, Irene Ryan, Wiley Robinson, Tom Wyman, Don Bruce, Jack Crooker, Charles Smith, and Burton Anderson.

In lieu of a Christmas party this year, the Section held a dinner-dance on November 12. About 40 people turned out for the affair.

• **The Colorado Section** held its monthly dinner meeting November 17 at the Petroleum Club. About 40 people attended the meeting, at which the Viola Vestal Coulter Award [scholarship] was presented to Charles Henry Burt. The program for the evening featured a talk by Paul V. M. Svendsen entitled *Direct Reduction Processes for Iron Ores.* A question and answer period followed the talk.

Personals

Richard V. Colligan has been elected vice president of Freeport Sulphur Co., according to a recent announcement. Mr. Colligan has spent most of his 20 years with the company in pursuit of its minerals interest in Cuba. His last post, which he retains, is that of president of the Moa Bay Mining Co., a Freeport subsidiary which produced nickel and cobalt concentrate before its facilities were seized by the Cuban government.

John Barclay, Jr., geologist with Ashanti Goldfield Corp. Ltd., Ghana, is on leave in England.

E. H. MILLER

G. R. FOX

Earl H. Miller, resident manager of the U.S. Borax & Chemical Corp. plant in Carlsbad, N. M., has been elected to the board of governors of the Western Div. of the American Mining Congress.

George R. Fox, works manager of Joy Mfg. Co. plants in Franklin, Pa., has been elected vice president of manufacturing, Joy International, S.A., a wholly-owned subsidiary which guides the company's overseas operations from headquarters in Monaco. **R. A. Lehner,** vice president and assistant general manager of Joy's Coal Machinery Div., will assume, in addition to his present duties, responsibilities of works manager at the Franklin plants until a new manager is appointed.

After two years as acting concentrator superintendent for Nchanga Consolidated Copper Mines Ltd., **Bernard Barlin** has joined Bancroft Mines Ltd. as concentrator superintendent. Both companies operate in Northern Rhodesia.

John Naylor has been transferred by his firm, Tipton & Kalmbach Inc., from Quito, Ecuador, to Lahore, Pakistan, where the firm is engaged in canal work for the West Pakistan Water and Power Development Authority.

Following graduation from McGill University, Toronto, **J. S. de Villiers,** an Afrikander, returned to South Africa to take a job with African Metals Corp. He had been working for Rio Tinto Canadian Exploration Ltd. during his summer vacations.

Gordon H. Crouch, formerly mill engineer for N. J. Zinc Co., has moved West to accept a position as mill metallurgist for the Texas-Zinc Mineral Corp., at Mexican Hat, Utah.

J. W. COLE

P. J. BAUKOL

John W. Cole, formerly projects engineer with Sunshine Mining Co., left after seven years to accept a position as mining engineer with the U.S. Bureau of Mines, Division of Foreign Activities. His first assignment, under the sponsorship of the U.S. Operations Mission to Indonesia, is that of mining advisor to the government of the Republic of Indonesia.

Philip J. Baukol has opened an engineering office in Vancouver, where he will specialize in plant layouts based on the clients' flowsheets and construction design engineering for the mining and other processing industries. Mr. Baukol has maintained a consulting service in Berkeley, Calif., for many years.

Howard Steven Strouth has just returned from his annual trip to Latin America. He reports that in Chile the new San Juan mine is now in production and that a satisfactory long-term lease has been worked out for the flotation mill at Llay Llay to process the ore.

In Peru, states Mr. Strouth, work continues on the Cerro Landa deposit and the adjoining Huambo claims, on which a large tonnage of copper ore has been developed. Other projects going forward include a sulfur plant in the Piura region, work on the Chimbote magnetite claims, and a gold and silver operation in the Arequipa region.

Exploration and exploitation of a vast area near the Peruvian border of Ecuador are underway and exploration of the Esmeraldas region for oil has been proposed.

Bituminous Coal Research Inc. announced recently that **Martin H. Rogoff, Irving Wender,** and **Melvin P. Silverman,** all of the U.S. Bureau

CHANGE OF ADDRESS AND PERSONALS FORM

CHANGING YOUR ADDRESS? Don't forget to notify us six (6) weeks before you move, if possible, to insure uninterrupted receipt of your publications and correspondence. Please fill in the form below and send it to: J. F. Lynch, Asst. Treasurer AIME, 29 West 39th Street, New York 18, N. Y.

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PERSONALS: Please list below your former company and title and your new title and company (or new work) for use in MINING ENGINEERING. (Copy deadline for personals items is six weeks before date of issue.)

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Former Company .....

Former Title ..... Length of Time There .....

New Company .....

New Title ..... Date of Change .....

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Any recent activity that would be of interest to members:

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of Mines, Pittsburgh, were recipients of its award for the best paper pertaining to coal and derived products presented at the 1960 Fall Meeting of the Division of Gas and Fuel Chemistry of the American Chemical Society. The paper, presented by Mr. Rogoff, was entitled *The Elimination of Sulfur from Coal by Microbial Action.*

According to a recent announcement from the Utal Copper Div. of Kennecott Copper Corp., **Wayne Burt** and **Ray Gough** have been appointed to two newly created positions. Wayne Burt was named general superintendent of smelting and refining operations and Ray Gough was named general superintendent of mining and concentrating. Mr. Burt was formerly refinery superintendent and Mr. Gough was operations superintendent at the mine.

George E. Aiken, formerly mine superintendent with Orinoco Mining Co. in Venezuela, has become advisor to Compañia de Acero del Pacifico. He has returned to the U. S. and is making his home in Minneapolis.

Robert B. Brackin has been appointed manager of columbium properties of Kennecott Copper Corp. Before joining Kennecott in 1959, Mr. Brackin was with E. I. du Pont de Nemours & Co.

Long-Airdox Co. recently announced the appointment of **Paul C. Manley** as vice president and general manager. In his new capacity he will supervise overall operations of the company and coordinate the manufacturing activities of Long-Airdox plants in West Virginia, Pennsylvania, Iowa, and Illinois.

P. C. MANLEY

J. C. TALIAFERRO

John C. Taliaferro was recently appointed manager of hydraulic dredge sales at Morris Machine Works. Before coming to Morris, Mr. Taliaferro was president and co-owner of a General Motors diesel engine distributorship and previous to that was division sales manager of the Ellicott Machine Corp. for ten years.

Herbert E. Jones, Jr., president of Amherst Coal Co., recently reported on his State Department mission to India as a member of an American coal team to help increase that country's coal output. **Raymond E. Salvati,** president of Island Creek Coal Co., headed the team, which included **E. R. Phelps,** then president of Pittsburg & Midway Coal Mining Co., and **Carlton Saunders,** administrative assistant to Mr. Salvati.

Mr. Jones said that in a two-week trip the team visited 25 mines and traveled 3000 miles. India produces about 60 million tons a year—almost half by strip mining—which is less than half of West Virginia's coal production. West Virginia employs fewer than 50,000 men in the mines; India employs 400,000, including some 60,000 women in surface operations. West Virginia produces 12 tons per man per day; India produces less than one ton per man.

Some Indian strip mines are as modern as any in the U. S., Mr. Jones reported, and some underground mines use shuttle cars, loading machines, and other modern devices. However, most of the coal produced in India is loaded into baskets and carried on men's heads to a mine car or conveyor.

"To a coal man it was a refreshing experience to see a country whose economy was based on coal," Mr. Jones said. "Coal powers the railroads, powers the electric utilities, powers the steel mills, supplies the energy for the cement mills and all the other industries and is the keystone to India's economy."

Wallace L. Larsen, formerly resident engineer with the Illinois Highway

personals

continued

Dept., has become assistant engineer with the South Dakota Highway Dept.

James F. Roe has joined Smith-Douglas Co., Texas City, Texas, as general manager. He was previously manager of Florida operations for International Minerals & Chemical Corp.

George W. Mao has accepted a position as senior research metallurgist, Central Research, Minnesota Mining & Mfg. Co. For the past two years he served as group leader, research and development, for Foote Mineral Co.

Following a year as mining engineer with Oglebay-Norton Co., **George R. Magnuson** has taken a position as industrial engineer with Joy Mfg. Co. in Claremont, N. H. He was recently appointed project engineer on the manufacture of the Holo-Flite processor.

According to a recent announcement by **M. F. Williams,** manager of Columbia-Geneva Steel's raw materials research laboratory, **Howard Evans** has been named general supervisor of mineral processing. Mr. Evans had previously served as supervisor of the beneficiation laboratory of Columbia Iron Mining Co. in Cedar City, Utah.

Richard M. Foose, chairman of the department of earth sciences at Stanford Research Institute, recently returned from an extended visit to Europe and Asia involving geological investigations in Iran, participation as the delegate of SME at the International Geological Congress meetings in Copenhagen, and a month-long tour of universities and scientific institutes in the Soviet Union.

A. F. Frederickson has joined the University of Pittsburgh as chairman of the department of geology, where an expanded research and graduate training program is being organized. He was formerly a professor of geology at Washington University in St. Louis before he joined the Pan American Petroleum Corp. to organize the corporation's geological research program, which he supervised for five years. He left this position to accept the appointment to the staff of the University of Pittsburgh.

Roy Jure has been appointed manager of the Exploration Dept. of American Metal Climax Inc. He was formerly assistant manager and succeeds **Jack A. James,** who recently resigned to engage in private geological consulting work, with headquarters at 211 Bellair Road, Ridgewood, N. J.

Miro Mihelich, formerly an engineer with the Alaska Department of Public works, has taken a job as mining engineer with Alaska Division of Mines and Minerals.

According to a recent announcement from Consolidated Purchasing and Designing Inc., **H. B. James** has been elected a director and president of the company.

R. B. Tippin, formerly with Duval Sulphur & Potash Co., Carlsbad, N. M., has become associated with International Minerals & Chemical Corp., of the same city.

Peter Morrison has taken a position with Sutro & Co., San Francisco. He was formerly treasurer with Advanced Instrument Corp. of Richmond, Calif.

George F. McKereghan recently resigned from Calumet & Hecla Inc., where he was an administrative engineer, to join Mine Management Associated Ltd., the agents for National Iron Ore Co. Ltd. of Monrovia, Republic of Liberia, Africa. He will be chief engineer in the development of a new open pit iron mine located in the Mano River District of Liberia.

F. F. Greene has taken a job as geologist with Bear Creek Mining Co. in Ely, Nev. He had been working as engineering draftsman for Boeing Airplane Co.

Paul H. Fessenden, who had been mine foreman with New Jersey Zinc Co. in Gilman, Colo., for seven years, has joined American Gilsonite Co., Bonanza, Utah, as assistant mine engineer.

Roger L. Minerman has moved from Climax, Colo., where he was assistant ventilation engineer for Climax Molybdenum Co., to Bishop, Calif., where he has taken a job with Union Carbide Nuclear Co. as mining engineer. He will be engaged in general mining engineering work, with emphasis on ventilation.

Menelaos D. Hassialis, chairman of Columbia University's mining, metallurgical, and mineral engineering department, has been named recipient of the Lion Award for 1960 by the Columbia Alumni Club of Bergen County, N. J. The award is presented each year to an alumnus who has distinguished himself by bringing credit to the University, Bergen County, and the community in which he lives. In 1958 Professor Hassialis received a Great Teacher Award conferred by the Columbia University Society of Older Graduates upon teachers who have won the esteem of their students. Known as one of the country's foremost mining engineers, Professor Hassialis was a U. S. delegate to the Geneva Conferences on the peaceful uses of atomic energy

in 1955 and 1958. He also served as a U. S. representative to the UNESCO meeting on atomic energy in Paris.

The Board of Directors of The Berwind-White Coal Mining Co. recently announced the election of **Thomas J. Willing** as vice president —sales. Mr. Willing joined the company's sales department in 1941 and was appointed district sales manager in 1947 and general sales manager in May 1960. He will continue to maintain his office in Philadelphia.

Clarence H. Sleeman has joined Koppers Co. Inc. as chief mining engineer for the Foreign Dept. in the Engineering & Construction Div. He will be primarily concerned with development of the El Algarrobo iron ore deposit of Compañia del Acero del Pacifico, S. A., in Chile. Mr. Sleeman was formerly chief mining and development engineer for the Ore Mines & Quarries Div. of Jones & Laughlin Steel Corp.

F. G. van der Hoeven has returned to Holland to undertake some theoretical studies for a Ph.D. at Delft University. He had been working at the University of Wisconsin, where he wrote a report on recent geophysical studies in the Antarctic.

Four top executives of bituminous coal companies, all directors of the

G. A. SHOEMAKER

R. E. SALVATI

H. LaVIERS

F. S. ELFRED

National Coal Assn., have been appointed to represent the coal industry on the advisory committee to the Office of Coal Research, established by Congress in 1960 in the Department of the Interior. They are **G. A. Shoemaker, Raymond E. Salvati, Harry LaViers,** and **F. Stillman Elfred.**

The Arthur L. Day gold medal of the Geological Society of America, one of the most important honors of its kind, has been awarded to **Konrad B. Krauskopf,** associate dean of Stanford University's School of Min-

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personals

continued

eral Sciences, for his research on the characteristics of orebearing fluids. The citation noted that his work has contributed to a better understanding of the physical chemistry of ore solutions and the rare metals in sea water and in sedimentary rocks. The award was made in absentia, as Mr. Krauskopf is on sabbatical leave in Goettingen, Germany, where he is studying thermodynamics. He will teach at Massachusetts Institute of Technology before returning to Stanford in the fall of 1961.

J. H. Cooper, formerly a computer with Republic Exploration Co., has moved to Wilmington, N. C., to become resident engineer for Henry Von Qesen & Associates, consulting engineers.

William L. Rice has left Reynolds Metals, where he worked as senior analyst, to become assistant geologist in the Geology Division of Northern Pacific Ry.

John C. Howbert, mining engineer with American Metal Climax Inc., has been transferred from the Denver exploration office to the Mining Dept., Mining & Exploration Div., in New York.

According to a recent announcement, **Charles A. McKinley** has been named general manager of silver, lead, zinc, and manganese dioxide mining and milling operations for Trout Mining Co. at Phillipsburg, Mont. Before joining Trout Mining Co., Mr. McKinley was general manager of the Sidney Mining Co., Kellogg, Idaho.

Robert T. Reeder has become associated with White Pine Copper Co. as assistant general superintendent in charge of mine production. He was formerly a mining engineer with the U.S. Geological Survey.

After nearly 40 years of activity in Mexico and Peru, **John G. Reilly** has retired but will continue to reside in Lima, Peru. At the time of his retirement, Mr. Reilly was vice president and general manager of Northern Peru Mining Corp., where he had been for the past five years. Prior to that he had been in Mexico, where for many years he was managing director for Cia. De Real Del Monte Y Pachuca, and later with American Smelting & Refining Co.

Peter T. Flawn has been named director of the Bureau of Economic Geology and professor of geology at the University of Texas. He succeeds the late John T. Lonsdale as state geologist.

C. E. Gregory has recently been promoted to reader in mining engineering at the University of Queensland, Brisbane, Australia.

Stephen P. Ogryzlo was recently appointed director and executive vice president of Copper Rand Chibougamau Mines Ltd.

George C. Heikes, formerly manager—mineral resources, Continental Materials Corp., Chicago, is presently serving with the International Cooperation Administration as chief of the mining division of the economic and technical assistance mission in Korea.

George C. Heikes *demonstrates his ability to write Korean to* **Mrs. Kim Hae Ran,** *an instructor at Yonsei University in Seoul, where he has just completed an 80-hr course in the language. All American personnel in the economic and technical assistance mission are required to take the language training course in reading and writing.*

Obituaries

Edmond V. Given

An Appreciation by
Harry K. Burke

It is with great regret that the members of the staff of San Manuel Copper Corp. have to record the death on Sept. 7, 1960, of Edmond Vern Given (Member 1943), mill superintendent. His passing brought to a close a distinguished career in mining and in mineral beneficiation.

Mr. Given, known to his friends as Vern or Slim, was born in Newcastle, Wyo., and raised at Gillette. His love for mining began at the age of 18 when he was living in Nevada. In the 1920's and early 1930's Vern worked in many of the active mining and milling operations throughout Nevada, California, and Utah. Later he settled in northwestern Arizona.

From 1937 to 1940 he served as foreman and acting superintendent of the old Arizona Magma operations at Chloride, broadening his keen insight and experience, which he later shared with those in allied professions.

Prior to World War II, he supervised milling operations at a Pb-Zn property in northern Sonora, Mexico, for American Smelting & Refinery Co. Following depletion of the ore deposit, he returned to Arizona in 1944 and built the Coronado copper and zinc mill in the Benson-Wilcox area. In 1945 he became mill superintendent at the old Tiger property of the Mammoth-St. Anthony Development Co.

Vern was with the Tiger property until it was purchased by the San Manuel Copper Corp., at which time he accepted employment with Newmont Mining Co. as director of milling operations in French Morocco.

After completion of his tour, he became mill superintendent of the San Manuel Copper Corp. in May 1955.

He was an active member of the Institute, particularly in the Arizona Section, supplying technical data, papers, and lectures. He is going to be keenly missed, and his untimely passing has left a gap that will be hard to fill.

A Tribute to Robert W. Hughes

from the Minutes of the
Arizona Section

Robert William Hughes, outstanding as an engineer and mine manager, and an active supporter of the AIME (Member 1926) and its Arizona Section, died in Phoenix on Sept. 10, 1960.

No greater tribute can be paid to any man, during his lifetime, than was shown in the friendly, affectionate, any yet respectful way he was called "Bob by everyone, including all of his employes, the labor leaders who dealt with him, the leaders in the mining profession, as well as bank presidents, senators, and others.

Bob Hughes was born in Fairhaven, Wash., in 1891. He received his primary education in the public schools of Mankato, Minn., and graduated from the University of Wisconsin in 1915 with a B.S. in mine engineering. He came to the Globe-Miami district in 1915 and obtained employment at Inspiration Consolidated Copper Co. In 1924, when Miami Copper Co. started block caving, he joined that organization as chief mine engineer.

He advanced steadily in the Miami organization, becoming mine superintendent in 1936, general manager in 1944, and vice president and general manager in 1953. Ill health forced his retirement from active duty on Jan. 1, 1957, but he continued to serve Miami as consulting engineer after retirement.

He successfully directed the operations of Miami Copper Co. through a period characterized by a constantly decreasing grade of ore and rising costs of inflation. His fundamentally optimistic point of view and his touch of humor guided the staff through many a tough spot.

His contribution to the profession was in demonstrating profitable operation on ore so low grade that others might have scorned it as waste. Despite this contribution, Bob Hughes will be remembered more for the very human manner in which he filled the job as general manager. His office door was always open to any employe.

He was active in the local mining organizations, having served as governor of the Arizona Chapter, American Mining Congress, and as Chairman of the Arizona Section of the AIME. He had many close personal friends in the Arizona Section, and in recent years he limited his social activities to attending the meetings of the Maricopa Subsection and the annual meeting in Tucson.

His devotion to his profession, his fairness in human relations, and his friendliness in all his activities will be long remembered by those who knew him.

William W. Logan (Member 1916), 79, died Sept. 6, 1960, in Oakland, Calif. Born in Scotland, Mr. Logan came to this country as a boy and attended high school in Oakland, Calif., and the University of California. He began his career as fieldman for the City of Tucson, Ariz. In 1911 he moved to Nevada, where he worked first as mining engineer and assistant superintendent for the Atlas Wonder Mining Co. and, successively, as millman for Churchill Mining Co. and assistant superintendent for U. S. Tungsten Corp.

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Obituaries

(Continued from page 215)

W. P. Schumacher (Member 1931) died in an El Paso hospital Aug. 11, 1960, at the age of 78. A retired executive of the Mexican Mining Dept. of American Smelting & Refining Co., he had been a resident of El Paso for 35 years. He was born in Quincy, Mass., and graduated from the Massachusetts Institute of Technology. Almost from the beginning of his career, Mr. Schumacher had been associated with the Mexican mining industry and in 1908 began his long association with American Smelting & Refining Co.

Lester C. Uren (Member 1917), who received the Mineral Industry Education Award for 1960, died Aug. 21, 1960, at the age of 72. A native of California, he attended the California School of Mechanical Arts and the University of California. Aside from short-term jobs while still at school and for the first year following graduation from the University of California, Mr. Uren had been a member of the faculty of the University of California at Berkeley. He began as a research assistant and became, successively, instructor, assistant professor, associate professor, professor and, in 1956, professor emeritus. He served as consultant to many oil companies and was the author of three outstanding textbooks in the field of petroleum engineering.

George Plews (Member 1943) died Aug. 13, 1960, shortly before his 68th birthday. He was born in St. Helens, England, attending the municipal technical school and Wigan Mining College. In 1913 he went to Chile as chemist for Braden Copper Co. During World War I he served first as a cadet in the Royal Flying Corps, then in the U.S. Army Ordnance Dept. He became a U.S. citizen and following his U.S. Army service went to Peru as chemist with Cerro de Pasco Corp. From 1923 to 1928 he was an engineer for Hardinge Co. Inc. in Salt Lake City. In 1928 he moved to California, where he resided until his death.

Donald M. Davidson (Member 1933), president of E. J. Longyear Co., died Sept. 15, 1960, at the age of 58. He had been associated with Longyear since 1939, when he joined the company as chief geologist, and became president in 1958. Just a few weeks before his death he completed a trip which took him around the world on consulting business for the company. Mr. Davidson was born in Quincy, Ill. A geologist with a world-wide reputation, he graduated *magna cum laude* from the University of Minnesota in 1925 and received a Ph.D. in geology from the University in 1928.

K. F. Göransson (Legion of Honor Member 1901) died in Sandviken, Sweden, where he was born on June 12, 1879. For more than 50 years he was associated with Sandvik Steel Works in Sandviken, becoming president in 1920, a position he held until his retirement. Before settling down in his home town, Mr. Goransson served on the technical faculty of the University of Lausanne, Switzerland, worked in industry in Germany and England, and took a year of graduate work at Columbia University in New York City.

J. McClelland Henderson (Legion of Honor Member 1896) died at the age of 88 in Pietermanitzburg, Natal, South Africa, on Aug. 2, 1960. Mr. Henderson was born in London and received his education at the Royal Saxon School of Mines, Freiberg-Saxony, and the University of Jena. He began his career as mine manager in the Cripple Creek District of Colorado, followed by a year as manager of Wyoming (Popo-agie) Oil Wells. In the early 1900's he began his career as a consulting engineer, working for the most part in Africa. Among the companies he did consulting work for were Henderson's Transvaal Estates Ltd., Daggajontein Gold Mining Co., and Tyne Valley Collieries. During the 1920's his work took him to South and Central America. He returned to Africa in 1938, making his headquarters in Natal.

PREPRINTS AVAILABLE

From SME Fall Meetings

The following list of papers will be available until Nov. 1, 1961. Coupons received with the 1961 dues bill and those distributed at the 1961 Annual Meeting are valid for these papers. Purchased coupon books are honored at any time.

Coupons books may be obtained from SME for $5 a book (10 coupons) for Members or $10 a book for Nonmembers. Each coupon entitles the purchaser to one preprint.

COAL DIV.—ST. LOUIS SECTION MEETING, September 1960

60F300 Stripping Machinery Mass, Overburden Volumes Relationships by *Henry Rumfelt.*
60F301 Oklahoma-Arkansas Coals by *B. L. Curry.*
60F302 Shaft Sinking and Lining in the Southern Illinois Coal Field by *J. W. MacDonald.*

AIME-ASME JOINT SOLID FUELS CONFERENCE, October 1960

60F400 Mechanical Mining in Low Seam Mines by *Clyde H. Storey.*
60F401 Our Knowledge of Underground Gasification in the USSR and a Comparison with US Processes by *C. D. Pears and Milton H. Fies.*

Send coupons, properly filled out to:

Preprints, SME, 29 West 39th St., New York 18, N. Y.

Robert C. Moffitt (Member 1920) died Sept. 21, 1960, in Seattle, Wash. He was born in Wallace, Idaho, on April 25, 1895, and received his education at The Hill School and Cornell University. He took graduate work at the School of Mines, University of Washington. His professional activities ranged from underground mine work to a position with the Engineering Department of the Washington Water Power Co. involving design of bridge structures, penstocks, tanks, gates and gate-lifting mechanisms, and hydraulic equipment. He also was engaged in private investigation, investments, and mining activities; experimental engineering on marine internal combustion engines; and the design, construction, and testing of a small solid injection type diesel engine.

Rollin A. Pallanch (Member 1925) died Sept. 29, 1960, in a Salt Lake City hospital at the age of 69. A native of Wisconsin, Mr. Pallanch received his education at the Madison High School and the University of Wisconsin. Following his graduation he came to Utah to take a job with General Engineering Co. In 1916 he went to work for U. S. Smelting Refining & Mining Co. doing flotation research. He evolved and patented the use of sodium sulfite as a flotation reagent. He became superintendent of U. S. Smelting & Refining's Midvale concentrator in 1929 and continued in that capacity until the early 1950's. From 1953 through 1955 he served the company in the capacity of consulting mill metallurgist.

E. H. Stevens (Member 1951), who had suffered from ill-health for many years, died during the summer of 1960. A member of the faculty of the South Dakota School of Mines and Technology, Rapid City, S. D., since 1949, he had planned to take a leave of absence for the current academic year. From 1935 to 1942 he was a member of the faculty of the Colorado School of Mines. He also carried on an intermittent consulting practice while engaged in his teaching work. Mr. Stevens was born in Chicago, Ill., on October 7, 1908. He attended the University of Chicago, where he received both his B.S. and Ph.D. degrees.

Ira L. Greninger (Member 1915) died recently in Spokane, Wash., at the age of 82. He was born in Moscow, Idaho, later moving to Oregon, where he attended public school. In the early days of his mining career he worked as assistant superintendent at Greenback mine in Josephine County, Oregon; as shift boss at Blue Ledge mine in Siskiyou County, California; and as general foreman for Balaklala Consolidated Copper Co., Shasta County, California. He became general mine foreman for Inspiration Consolidated Copper Co. at Miami, Ariz., in 1915. Throughout the 1950's, after he had retired from active work, he lived in Scarsdale, N. Y., moving to Spokane shortly before his death.

C. O. Lindberg (Legion of Honor Member 1907) died Sept. 2, 1960, in New York City shortly before his 81st birthday. He was born in Stockholm, Sweden, and received his early education in Stockholm and in Berlin, Germany. He then attended the Royal Swedish War Academy until he was 20 years old. Coming to the U.S. in 1900, he spent four years working in the accounting department of a railroad. In 1904 he enrolled in the Michigan College of Mines, earning a B.S. degree in 1906 and continuing on as a graduate student. He began his career with W. Rowland Cox as an examining mining engineer in 1912. In 1914 he set up a consulting practice with headquarters in Los Angeles. Over the past decade he had served as consultant for Gold Fields American Development Co. Ltd.

John F. Magee (Member 1927), chairman of the Board of Directors of Alpha Portland Cement Co., died Aug. 3, 1960. He had joined the company following his graduation from Lafayette College in 1913 and remained until his death. He was born in Easton, Pa., on Dec. 16, 1892, and lived there all his life.

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Obituaries

(Continued from page 217)

Robert J. Miller (Member 1860), chief mining engineer for Alabama By-Products Corp., died recently at the age of 52. Most of his career was spent in the coal industry except for a four-year period with E. I. du Pont de Nemours & Co., where he supervised chemical plant construction in three locations. His association with Alabama By-Products Corp. began in 1952 when he joined the company as chief mining engineer. Mr. Miller was born in Pikeville, Ky., where he attended high school. He studied civil engineering at Virginia Military Institute and business management at Columbia University.

F. William Nobs (Member 1922) died on May 2, 1960, in Grass Valley, Calif. He was born Nov. 28, 1881, in St. Paul, Minn. Following his graduation from Stanford University in 1905, he went to work for Standard Consolidated Mining Co. From 1906 to 1913 he worked for various mining companies in Mexico and Central America. After a year as consulting geologist and engineer with an office in San Francisco, Mr. Nobs became associated with Empire Mines, Grass Valley, Calif., as geologist. By 1918 he was general manager for the company. He continued to make his home in Grass Valley after he retired in the mid-1950's.

Merle F. Otto (Member 1941) died of a heart attack Aug. 4, 1960, shortly before his 52nd birthday. A native of Nebraska, he received his education at the University of Nebraska. He began his professional career as a mucker for Homestake Mining Co. in the 1920's. Over the years he worked for a number of mining and engineering companies as miner, timberman, operator, foreman, engineer, mine accountant, and mine surveyor. In 1940 he joined Molybdenum Corp. of America as chief mining engineer. At the time of his death, Mr. Otto was design engineer for American Potash & Chemical Co. in Trona, Calif.

Carel Robinson (Member 1932) died at his home in Charleston, W. Va., Sept. 20, 1960, after a short illness. A consulting engineer since 1920, Mr. Robinson and his son, Neil Robinson II, had operated the consulting firm of Robinson & Robinson since 1940. His consulting work included studies by him and his firm of the entire Belgian coal industry as well as French, German, and Turkish mines under the auspices of the Marshall Plan. Coal was his chief interest and he had done studies on coal properties in all major coal-producing areas in the U.S., Canada, and Alaska. He had also undertaken extensive consulting work in Russia.

Mr. Robinson was born in Coalburgh, W. Va., on Feb. 6, 1881, and was educated in Charleston schools and West Virginia University.

Gust J. Salmi (Member 1944) died in Charcas, Mexico, in his 58th year. He was born in Matku, Finland, but came to the U.S. while still a boy and attended high school in Aurora, Minn. He began his career as foreman of a sintering plant for Mesabi Iron Co. in Babbitt, Minn. In 1926 he began his long association with American Smelting & Refining Co. in Mexico which lasted until his death.

Quincy A. Shaw (Member 1928) died May 8, 1960, at the age of 90 in Boston. A native Bostonian, Mr. Shaw received his education at Harvard University. Following his graduation in 1891, he went to Calumet, Mich., where he entered the employ of the Calumet & Hecla Mining Co., staying there two years. In 1894 he was elected a director of the company. He was president for many years. At the time of his death he

1961 SME PREPRINTS AVAILABLE—LIST IS NOT COMPLETE

The following SME 1961 Annual Meeting (St. Louis) papers are now available (Jan. 3, 1961). As more papers become available, they will be added to the list. Preprints are listed by title and number; please order by number. **Preprints are obtained only on a coupon basis.**

Preprints may be obtained (upon presentation of properly filled out coupon) from Preprints, SME Headquarters, 29 W. 39th St., New York 18, N. Y.

Adaptability of Illinois Coal for Use in Iron and Steel Production, **61F30**
Alimak Raise Climber at Iron King Branch of Shattuck Denn Mining Corporation, **61AU26**
Application of Marginal Analysis in the Determination of Cut-off Grade, The, **61AO21**

Basic Statistical Measures Used in Geochemical Investigations of Colorado Plateau Uranium Deposits, **61L37**
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H. A. Wagner (Member 1924) died April 11, 1960, a week before his 96th birthday. He was born in Grahamtown, N. Z., and first came to the U.S. in 1901, when he went to work for F. A. Heinze in Butte, Mont. He was educated at the University of Heidelberg, the Mining Academy of Freiberg, and the Polytechnicum in Zurich. His first job was in Cardiff, Wales, as a metallurgist with Dowlais Steel & Iron Co. Subsequently he worked in Africa, the East Indies, and Sumatra. In 1909 he was back in the U.S. doing research work on ore treatment. He had done consulting work in Kansas City and Joplin from 1910 to 1913, and then again beginning in 1916. At the time of his death he had a consulting practice in Chicago.

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1916	B. S. Butler	Nov. 13, 1960
1938	Claude C. Cushwa	Nov. 1, 1960
1927	Ray M. Henricksen	Unknown
1919	Harry P. Hill	Oct. 6, 1960
1922	George S. McCaa	Nov. 28, 1960
1940	Neal M. Muir	Nov. 5, 1960
1949	M. B. Nesbitt	Nov. 17, 1960
1936	E. P. Scallon	Nov. 19, 1960
1957	Hayden F. Sears	Nov. 19, 1960
1955	E. R. Thomas	Unknown
1930	Andrew Walz	1959
1936	George H. Waterman	Sept. 22, 1960
1917	R. R. Wilson	Nov. 20, 1960
1914	E. H. Comstock	April 1960
1943	J. O. Cree	June 13, 1960
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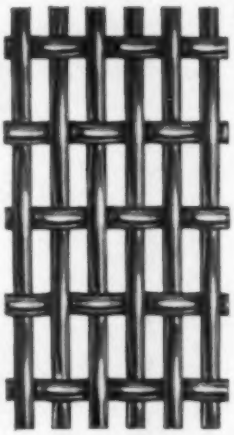

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